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EDUCATION DEPT.

THE

FIRST BOOK OF BOTANY.

DESIGNED TO CULTIVATE

THE OBSERVING POWERS OF CHILDREN.

> . . . . Not that *more* is taught at an early age, but *less;* that time is taken; that the wall is not run up in haste; that the bricks are set on carefully, and the mortar allowed time to dry.
> LORD STANLEY.

> "You study Nature in the house, and when you go out-of-doors you cannot find her."—PROF. AGASSIZ.

BY

ELIZA A. YOUMANS.

NEW AND ENLARGED EDITION, WITH 300 ENGRAVINGS.

NEW YORK:
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1873.

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EDUCATION DEPT.

PREFACE.

This little book has a twofold claim upon those concerned in the work of education.

In the first place, it introduces the beginner to the study of Botany in the only way it can be properly done—by the direct observation of vegetable forms. The pupil is told very little, and from the beginning, throughout, he is sent to the plant to get his knowledge of the plant. The book is designed to help him in this work, never to supersede it. Instead of memorizing the statements of others, he brings report of the living reality as he sees it; it is the things themselves that are to be examined, questioned, and understood. The true basis of a knowledge of Botany is that familiarity with the actual characters of plants, which can only be obtained by direct and habitual inspection of them. The beginner should therefore commence with the actual specimens, and learn to distinguish those external characters which lie open to observation; the knowledge of which leads naturally to that arrangement by related attributes which constitutes classification.

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But the present book has a still stronger claim to attention; it develops a new method of study which is designed to correct that which is confessedly the deepest defect of our current education. This defect is the almost total lack of any systematic cultivation of the observing powers. Although all real knowledge begins in attention to *things*, and consists in the discrimination and comparison of the likenesses and differences among objects; yet, strange to say, in our vaunted system of instruction there is no provision for the regular training of the perceptive faculties. That which should be first and fundamental is hardly attended to at all. We train in mathematics, and cram the contents of books, but do little to exercise the mind upon the realities of Nature, or to make it alert, sensitive, and intelligent, in respect to the order of the surrounding world.

Something, indeed, has been done in the way of object-teaching, although but little that is satisfactory. These exercises are notoriously loose, desultory, incoherent, and superficial, and hardly deserve the name of mental training. What is wanted is, that object-studies shall become more close and methodic, and that the observations shall be wrought into connected and organized knowledge. It is the merit of Botany that, beyond all other studies, it is suited to the attainment of this end. Plants furnish abundant and ever-varying materials for observation. The elementary facts of Botany are so simple that their study can be commenced in early childhood, and so numerous as to sustain a prolonged course of observation. From the most rudimentary facts the pupil may proceed gradually to the more complex; from the concrete to the abstract; from observation to the truths resting upon observation, in a natural order of ascent, as required by the laws of mental growth. The means are thus furnished for organizing object-teaching into a systematic method, so that it may be pursued continuously through a course of successively higher and more comprehensive exercises. Carried out in this way, Botany is capable of doing for the observing powers of the mind what mathematics does for its reasoning powers.

Moreover, accuracy of observation requires accuracy of description; precision of thought implies precision in the use of language. Here, again, Botany has superior advantages. Its vocabulary is more copious, precise, and well settled, than that of any other of the natural sciences; it is thus unrivalled in the scope it offers for the cultivation of the descriptive powers.

On purely mental grounds, therefore, and as a means of attaining the most needed of educational reforms, Botany has a claim to be admitted as a fourth fundamental branch of common-school study; and the hope of contributing something to this end has been the author's main incitement in the preparation of this rudimentary work.

It is needful here to state that the method of instruction developed in these pages is no mere educational novelty; it has been tested, and its fitness for the end proposed has been shown in practice. The *schedule* feature which is here fully brought out, and which is its leading peculiarity as a mode of study, was devised and successfully used by Prof. J. S. Henslow, of Cambridge, England. My attention was first drawn to it as I was looking about in the educational department of the South Kensington Museum, in London. In a show-case of botanical specimens, I noticed some slates covered with childish handwriting, which proved to be illustrations of a method of teaching Botany to the young. They were furnished by Prof. Henslow for the International Exhibition of 1851. He died without publishing his method, but not without having subjected it to thorough practical trial. He had gathered together a class of poor country children, in the parish where he officiated as clergyman, and taught them Botany by a plan similar to the present, though less simplified. The results of this experiment have been given to the public by Dr. J. D. Hooker, Superintendent of the Botanical Gardens at Kew, who was summoned to give evidence upon the subject before a Parliamentary Commission on Education.

The following interesting passages from his testimony will give an idea of Prof. Henslow's method of proceeding and its results:

Question. Have you ever turned your attention at all to the possibility of teaching Botany to boys in classes at school?

Answer. I have thought that it might be done very easily; that this deficiency might be easily remedied.

Q. What are your ideas on the subject?

A. My own ideas are chiefly drawn from the experience of my father-in-law, the late Prof. Henslow, Professor of Botany at Cambridge. He introduced Botany into one of the lowest possible class of schools—that of village laborers' children in a remote part of Suffolk.

Q. Perhaps you will have the goodness to tell us the system he pursued?

A. It was an entirely voluntary system. He offered to enroll the school children in a class to be taught Botany once a week. The number of children in the class was limited, I think, to forty-two. As his parish contained only one thousand inhabitants, there never were, I suppose, the full forty-two children in the class; their ages varied from about eight years old to about fourteen or fifteen. The class mostly consisted of girls. . . . He required that, before they were enrolled in the class, they should be able to spell a few elementary botanical terms, including some of the most difficult to spell, and those that were the most essential to begin with. Those who brought proof that they could do this were put into the third class; then they were taught once a week, by himself generally, for an hour or an hour and a half, sometimes for two hours (for they were exceedingly fond of it).

Q. Did he use to take them out in the country, or was it simply lessons in the school?

A. He left them to collect for themselves; but he visited his parish daily, when the children used to come up to him, and bring the plants they had collected; so that the lessons went on all the week round. There was only one day in the week on which definite instruction was given to the class; but on Sunday afternoon he used to allow the senior class, and those who got marks at the examinations, to attend at his house. . . .

Q. Did he find any difficulty in teaching this subject in class?

A. None whatever; less than he would have had in dealing with almost any other subject.

Q. Do you know in what way he taught it? did he illustrate it?

A. Invariably; he made it practical. He made it an objective study. The children were taught to know the plants, and to pull them to pieces; to give their proper names to the parts; to indicate the relations of the parts to one another; and to find out the relation of one plant to another by the knowledge thus obtained.

Q. They were children, you say, generally from eight to twelve?

A. Yes, and up to fourteen.

Q. And they learned it readily?

A. Readily and voluntarily, entirely.

Q. And were interested in it?

A. Extremely interested in it. They were exceedingly fond of it.

Q. Do you happen to know whether Prof. Henslow thought that the study of Botany developed the faculties of the mind —that it taught these children to think? and do you know whether he perceived any improvement in their mental faculties from that?

A. Yes; he used to think it was the most important agent that could be employed for cultivating their faculties of observation, and for strengthening their reasoning powers.

Q. He really thought that he had arrived at a practical result?

A. Undoubtedly; and so did every one who visited the school or the parish?

Q. They were children of quite the lower class?

A. The laboring agricultural class.

Q. And in other branches receiving the most elementary instruction?

A. Yes.

Q. And Prof. Henslow thought that their minds were more developed; that they were become more reasoning beings, from having this study superadded to the others?

A. Most decidedly. It was also the opinion of some of the inspectors of schools, who came to visit him, that such children were in general more intelligent than those of other parishes; and they attribute the difference to their observant and reasoning faculties being thus developed. . . .

Q. So that the intellectual success of this objective study was beyond question?

A. Beyond question. . . . In conducting the examinations of medical men for the army, which I have now conducted for several years, and those for the East-India Company's Service, which I have conducted for, I think, seven years, the questions which I am in the habit of putting, and which are *not* answered by the majority of the candidates, are what would have been answered by the children in Prof. Henslow's village-school. I believe the chief reason to be, that these students' observing faculties, as children, had never been trained—such faculties having lain dormant with those who naturally possessed them in a high degree; and having never been developed, by training, in those who possessed them in a low degree. In most medical schools, the whole sum and substance of botanical science is crammed into a few weeks of lectures, and the men leave the class without having acquired an accurate knowledge of the merest elements of the science. . . .

The printed form or *schedule* contrived by Prof. Henslow, and used in these classes, applied only to the flower, the most complex part of the plant, and the attention of children was directed by it chiefly to those features upon which orders depend in classification. But, instead of confining its use to the study of a special part of plant-structure, it seemed to me to apply equally to the whole course of descriptive Botany, and to be capable of becoming a most efficient instrument of regular observational training. I accordingly prepared a simplified series of exercises on this plan, and used them to guide some little children in studying the plants of the neighborhood; and, had this experiment not been regarded, by those who witnessed it, as a success, the book embodying these exercises would not now appear.

The successful experience here referred to, which led to the publication of this book, has now been decisively confirmed by the public after a year's trial with it. It has had an extensive sale, has been introduced into many schools of all grades, has been much used by private students, and has been approved with a unanimity and earnestness quite unprecedented in the history of school-books based upon new methods of teaching.

A new edition now appears, with several additional chapters treating of the seed, germination, buds, the aspects of woody plants, etc. The descriptions will here be more full and general, but the plan of describing only the results of actual observations is still adhered to. Questions are asked, but no answers are given; these are to be got by direct inspection of the objects. Some simple experiments for the children to make are introduced, and they will now be more occupied in watching the changes which take place in the different parts of plants.

In arranging a course of observations for beginners in Botany, only those have been selected which may be made with the naked eye. In another book now in preparation the same plan of schedule study will be carried out, and provision made for more close and extended observations, requiring the help of magnifying-glasses.

There have been attempts to teach classes by the schedule method of this work by means of the blackboard, and without the book, but all such attempts are violations of the method. Botany cannot be "taught" by this system, for the very essence and soul of it is that the pupil is himself to find out what he wants to know. For repetition, comparison, and verification, constant reference to past exercises is required, which makes it indispensable that plant and book should go together. Only as a manual of practice, in individual observation, can the present work subserve the purpose for which it was prepared.

PUBLISHERS' NOTICE.

The essay on the EDUCATIONAL CLAIMS OF BOTANY, which was appended to former editions of this work, is withdrawn from the present edition. Believing it to be a very important addition to our educational literature, and that they can in no way better subserve the interests of sound progressive education, the publishers have reprinted the argument in a neat pamphlet for gratuitous distribution. The object of the essay is to trace the laws of mental growth, to explain the method of education which these laws require; and to show the special adaptation of Botany to carry out that method in the systematic cultivation of the observing powers.

The pamphlet treats of the following subjects:

I. How the body grows.
II. How the mind grows.
III. Extent of early mental growth.
IV. Nature's educational method.
V. Deficiency of existing school-methods.
VI. What is now most needed.
VII. Advantages offered by Botany.
VIII. Defects of common Botanical study.
IX. Aims of the present work.

Sent by mail to any part of the country on receipt of postage-stamp.

SUGGESTIONS TO TEACHERS.

THE method to be pursued by the aid of this book is the following: The child, whether at home or at school, first of all collects some specimens of plants—almost any will answer the purpose in commencing. These consist of organs, each of which is made up of different parts, and these vary in form and structure continually in different species. The object of the learner is to find out these parts or characters, and to learn their names, so as to be able to describe them.

The beginner, of course, must start with the simplest characters. Turning to the first exercises, for example, he finds the parts of leaves represented by pictures accompanied by the names applied to them. Guided by these, he refers to his specimens, and *finds the real things* which the pictures and the words represent. When a few characters are fixed in the mind by two or three exercises, he will commence the practice of *noting down* what he observes. For this purpose a form, or *schedule*, is used, containing questions which indicate what he is to search for. Models of these schedules, filled out, are given in the successive exercises: the pupil will make them for himself with pencil and paper.* He now carefully observes his specimen, and writes down the characters it possesses, with which he has thus far become acquainted. Having done this, he pins the specimen to the paper describing it, and brings it to the teacher as the report of his observation and judgment in the case.

---

* I have thought it desirable also to present the whole set, at the end of the volume, with the answers omitted, to illustrate at a glance the scope of this first series of observations. As the pupil is to be constantly engaged in *schedule practice*, and as the schedules are not to be preserved, the cheapest kind of paper will answer, and it can be of course used on both sides. Slates will do just as well; but then the description must be numbered, and a corresponding number attached to the specimen, so that they can be compared by the teacher.

This operation is constantly repeated upon varying forms, and slowly extended by the addition of new characters. He thus goes on discovering new parts and acquiring their names —noting the variations of these parts and the names of their variations. The schedules guide him forward in the right direction, and hold him steadily to the essential work of exercising his faculties upon the living objects before him. In every fresh collection of plants, new parts and new relations will solicit the attention, and will have to be observed, compared, and recorded. Particular kinds of plants, let it be remembered, *are not described in the book*—they are not even named; the object is, by constant practice and repetition, to train the pupil to find out the characters of any that come in his way, and make his own descriptions.

An acquaintance with Botany, although of course desirable, is not indispensable in using these exercises. Any teacher or parent *who is willing to take the necessary pains* can conduct the children through them without difficulty; and if they will become *fellow-students* with them all the better. The child is not so much to be *taught*, as to instruct himself. The very essence of the plan is, that he is to *make his own way*, and rely on nobody else; it is intended for self-development. Mistakes will, of course, be made; but the whole method is *self-correcting*, and the pupil, as he goes forward, will be constantly rectifying his past errors. The object is less to get perfect results at first than to get the pupil's opinion upon the basis of his own observations.

Children can begin to study plants successfully by this method at six or seven years of age, or as soon as they can write. But close observations should not be required from young beginners, nor the exercises be prolonged to weariness. The transition from the unconscious and spontaneous observations of children to conscious observation with a definite purpose should be gradual, beginning and continuing for some time with the easiest exercises upon the most simple and obvious characters.

CONTENTS.

PAGE

CHAPTER I.—THE LEAF.......... 15

Ex. 1. The Parts of a Leaf.......... 16
2. The Parts of a Grass-Leaf.......... 17
3. Venation.......... 18
4. The Framework and its Parts.......... 19
5. Feather-veined and Palmate-veined Leaves.......... 22
6. Margins.......... 24
7. Bases.......... 28
8. Apexes.......... 31
9. Forms of Lobes.......... 33
10. Forms of Sinuses.......... 35
11. Kinds of Leaves.......... 37
12. Shapes of Leaves.......... 39
13. Petioles, Surfaces, and Colors.......... 45
14. Simple and Compound Leaves.......... 47
15. Parts of Compound Leaves.......... 49
16. Pinnate and Digitate Leaves.......... 51
17. Varieties of Pinnate Leaves.......... 52
18. Varieties of Digitate Leaves.......... 54
19. Forms of Stipules.......... 57
20. Examples of Description.......... 59

CHAP. II.—THE STEM.......... 60

Ex. 21. Parts of the Stem, and Leaf Axil.......... 60
22. Appendages of the Stem.......... 62
23. Position of Leaves.......... 64
24. Arrangement of Leaves on the Stem.......... 66
25. Shapes of Stems.......... 69
26. Attitude of Stems.......... 71
27. Color, Surface, Size, Structure.......... 74

PAGE
CHAP. III.—THE INFLORESCENCE.......................... 76
Ex. 28. Solitary and Clustered Inflorescence................ 76
29. Parts of the Inflorescence......................... 78
30. Attitude of Inflorescence......................... 80
31. Solitary Terminal and Axial Inflorescence........... 82
32. Clustered Axial and Terminal Inflorescence.......... 84
33. Definite and Indefinite Inflorescence............... 87
34. Varieties of Inflorescence......................... 90

CHAP. IV.—THE FLOWER................................ 96
Ex. 35. Parts of the Flower............................ 96
36. Parts of the Calyx............................... 97
37. Parts of the Corolla.............................. 98
38. Kinds of Calyx................................. 99
39. Kinds of Corolla and Perianth..................... 100
40. Regular and Irregular Corollas and Perianths........ 101
41. Parts of Stamens................................ 103
42. Parts of the Pistil............................... 105
43. Parts of the Ovary............................... 105
44. Parts of the Petals............................... 107
45. Kinds of Regular Polypetalous Corollas............. 108
46. Kinds of Irregular Polypetalous Corolla............. 109
47. Parts of a Gamopetalous Corolla................... 112
48. Kinds of Regular Gamopetalous Corollas............ 113
49. Irregular Gamopetalous Corollas................... 114
50. Crowns, Spurs, and Nectaries..................... 118

CHAP. V.—THE ROOT.................................. 120
Ex. 51. Tap-Roots and Fibrous Roots..................... 120
52. Kinds of Tap-Root............................... 121
53. Kinds of Fibrous Roots........................... 122

EXAMPLES IN PLANT DESCRIPTION......................... 124

CHAP. VI.—THE SEED................................... 142
Ex. 54. Parts of the Seed............................... 142
55. Parts of the Body or Kernel....................... 145
56. Parts of the Embryo.............................. 147
57. Monocotyledons and Dicotyledons.................. 150

PAGE
CHAP. VII.—WOODY PLANTS.............................. 153
Ex. 58. Their Different Kinds.......................... 153
59. Parts of a Tree.................................. 156
60. Parts of the Trunk............................... 158
61. Kinds of Trunk................................... 159
62. Questions about Trees............................ 160

CHAP. VIII.—THE LEAF-BUD.............................. 166
Ex. 63. Parts of the Leaf-Bud.......................... 166
64. Vernation.. 167

CHAP. IX.—STEM AND ROOT.............................. 174
Ex. 65. What are Roots?................................ 174
66. Tubers, Bulbs, Corms, Rhizoma.................... 175

CHAP. X.—FRUIT.. 178
Ex. 67. What is Fruit?................................. 178
68. Sutures and Dehiscence........................... 180
69. Parts of Carpels................................. 182

CHAP. XI.—THE ACTIONS OF PLANTS....................... 184
Ex. 70. Root-action and Leaf-action.................... 184

LEAF SCHEDULES... 188

STEM SCHEDULES... 193

INFLORESCENCE SCHEDULES................................ 196

FLOWER SCHEDULES....................................... 199

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The First Book of BOTANY

CHAPTER I.—THE LEAF.

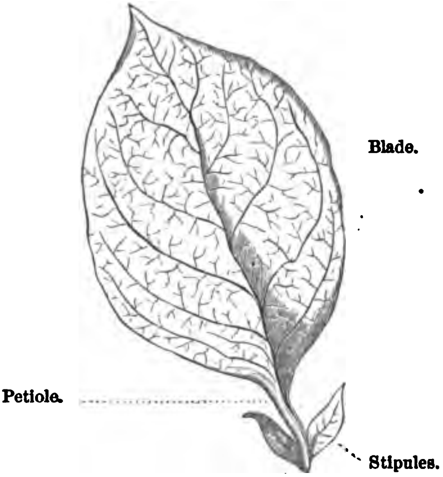
The pupil will see from the picture what is to be done first, and how we are to proceed in commencing the study of plants. Having collected some specimens, let us begin with the leaf. On these printed leaves there is a language which children have already learned; there is also a language written by Nature on the *leaves that grow:* we will now learn to read *that.*

EXERCISE I.

The Parts of a Leaf.

THE beginner will gather some leaves, and find out the names of their parts by comparing them with the picture.

FIG. 1.



BLADE.—The flattened green part of the leaf.

PET′IOLE.—The leaf-stalk.

STIP′ULES.—Small bodies at the base of the petiole, that look more or less like leaves.

NOTES FOR TEACHERS.—The exercises begin with leaves, because they are the simplest and the most common parts of plants, and because they present the greatest variety of forms, and are most easily procured. The aim of the first exercise is to teach the parts of a leaf and their names. It is likely that the first gathering of leaves will be done carelessly, and that,

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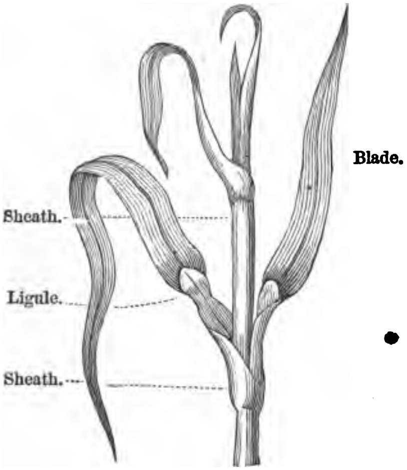
EXERCISE II.

The Parts of a Grass-Leaf.

Gather a handful of grass and see if you can find the parts shown in Fig. 2.

Fig. 2.



Blade.—The flattened upper part of the leaf.

Sheath.—A leaf-stalk surrounding the stem.

Lig′ule.—The scale-like stipule often seen between the sheath and the blade.

---

when compared with Fig. 1, the specimens will be found lacking in some of the parts there seen. This will make it necessary to repeat the exercise. At the second trial the leaves will be pulled with more care, and the pupil will seek for those having all the parts seen in the picture. Let him point out the parts in each of his specimens, and give them their names, repeating the process till he can do it without hesitation or mistake.

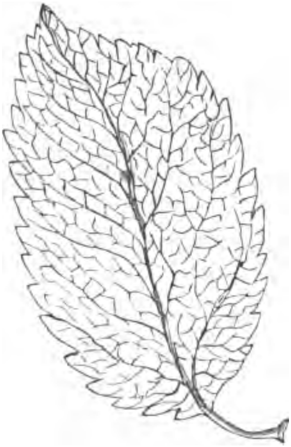
EXERCISE III.

Venation.

VENA′TION.—The lines seen upon the leaf-blade are called its venation.

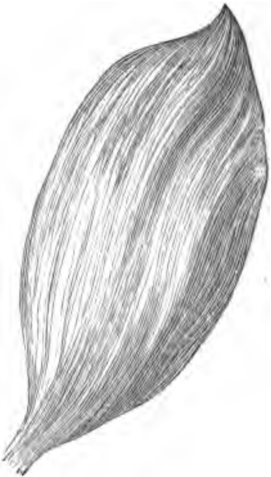
Hold up a leaf between your eye and the light, and, if you see a net-work of irregular lines, it is a net-veined leaf; but, if you see no such net-work, as in Fig. 4, it is a parallel-veined leaf.

FIG. 3.



A Net-veined Leaf.

FIG. 4.



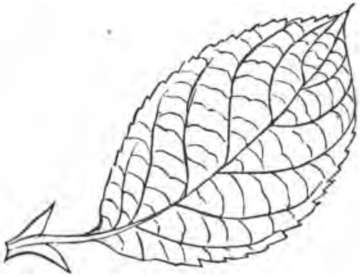
A Parallel-veined Leaf.

LOOKING AND OBSERVING.—There are plenty of boys and girls who have always lived in a garden, and yet, if you asked them the difference between a potato-leaf and a bean-leaf, they could not tell you. They have *looked* at potato-plants and bean-plants often enough, but they have never *observed* them.

When we observe a thing, we not only look at it, but, as we look, we think particularly about it. For instance, after these exercises, when you look at a leaf, you will think, what parts has it? and, is it net-veined or not? You will *observe* these particulars about it.

THE SCHEDULE.—That you may be sure to look at plants with care, and that your teacher may see what you think about them, little diagrams, called schedules, are used, in which you are to write down what you observe. They have questions written upon them, which you are to answer by studying the plants themselves.

FIG. 5.



SCHEDULE FIRST, DESCRIBING FIG. 5.

Parts?	*Blade, Petiole, Stipules.*
Venation?	*Net-veined.*

NOTE.—It will be observed that the attention of the child is restricted to one additional point at each exercise. This will prevent the confusion of ideas which is liable to arise when several new features of plant-structure are presented to the mind at the same time.

Here is such a schedule about Fig. 5. On the left, two words are printed with interrogation-points, which show that they are questions. The word Parts? means, what parts has this leaf? The word Venation? means, what is its venation? The answers to these questions are found by looking at the picture, and they are then written in the schedule as you see.

Take a sheet of ruled paper, and make a vertical pencil-mark an inch or two from the left edge; at the left of this mark write the questions, Parts? Venation? Now examine a real leaf, and opposite the question, Parts? write what parts you find. Look again at its venation, and write the answer to this question also. Pin each leaf upon the paper that describes it, and hand the collection to the teacher, to see if you have observed correctly.

EXERCISE IV.

The Framework and its Parts.

The lines upon the blade of a leaf, shown in Fig. 6, are made by its framework. The spaces between

---

Note.—A word of caution is here necessary against mistaking the purpose of this book for that of common botanies. The aim of ordinary botanical teaching is simply to impart to pupils a knowledge of plants. In our schools the ambition of both teacher and pupil is to get something done as quickly as possible that will show proficiency. Hence the early attempts at the classification of plants and the consequent precipitation these lines, which are darkened in Fig. 7, are, in the living leaf, filled with green matter.

FIG. 6.

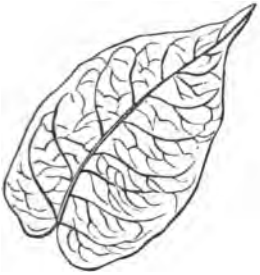


FIG. 7.

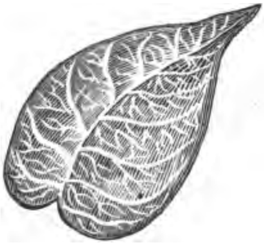
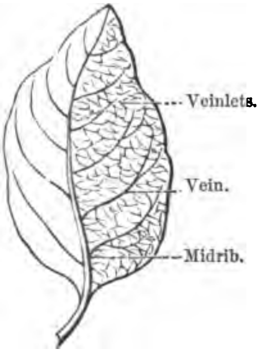


FIG. 8.



You know the names of the parts of a *leaf*, and the two following pictures will show you what to call the different parts of the *framework.*

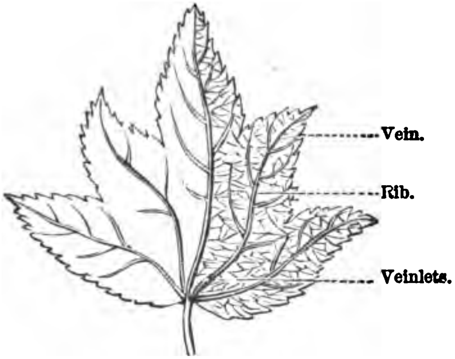
RIBS.—The stoutest pieces of the framework that begin at the petiole and reach quite across the blade, are called *ribs.* When there is but one, as in Fig. 8, it is called a *midrib.*

---

of the pupil into the complexities of the subject before the simpler portions have been sufficiently mastered.

Now, the aim of this book is carefully to guard against such a result. These first observations are made without reference to those combinations of characters by which plants are identified as belonging to a particular order, genus, or species. One of our aims is to learn the elementary facts so thoroughly and

FIG. 9.



VEINS.—The branches of the ribs are called *veins.*

VEIN'LETS.—The branches of the veins are called *veinlets.*

EXERCISE V.

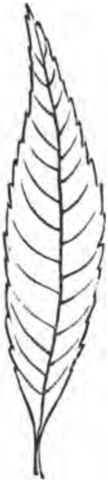
Feather-veined and Palmate-veined Leaves.

IF you have carefully compared a few living leaves with Figs. 8 and 9, you know the difference between ribs and veins.

---

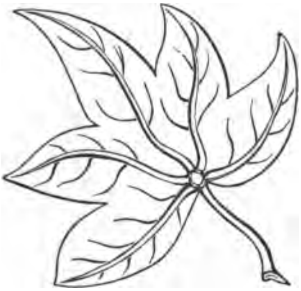
familiarly that we may be prepared to go forward and use them afterward. We first study the parts of plants one after another, on account of what they offer directly to observation. When the characters of leaves, stems, flowers, etc., have become familiar, their relations to each other in different plants, which are usually thrust upon the attention at the outset of study, will come to be seen with little effort. This spontaneous action will be sure to occur as soon as the pupil is prepared for it. All that need be done, therefore, is to keep the elements of the subject before the mind, and to acquire the use of accurate

FIG. 10.



Now, when a leaf has but one rib—a midrib—which gives off veins right and left, like Fig. 10, making it look something like a feather, it is called a feather-veined leaf; and when several ribs pass across the blade in a spreading fashion, as in Fig. 11, the leaf is said to be palmate-veined. Whoever named it so, must have thought the ribs looked like the spread-out fingers branching off from the palm of the hand.

FIG. 11.



If a leaf is net-veined, it will be in one of these two fashions. It will be either feather-veined or palmate-veined. In answering the question Venation? in your schedule, you may now state whether the leaf in hand is feather-veined or palmate-veined.

You may sometimes be troubled to decide whether a leaf is feather-veined or palmate-veined. Large veins near the base sometimes look very much like *ribs.* Compare your leaf carefully with the pictures and definitions, and write your opinion in the schedule. You may make mistakes at first, but further observation will enable you to correct them.

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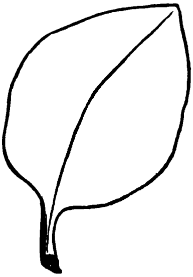
terms in description, without troubling ourselves about the higher growths of the science.

EXERCISE VI.

Margins.

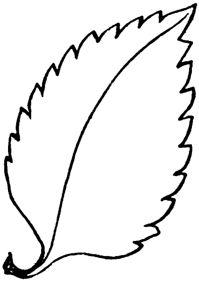
MARGIN.—THE edge of a leaf-blade is called its *margin.*

FIG. 12.



Entire.

FIG. 13.

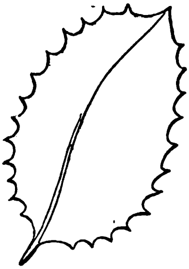


Serrate.

An ENTIRE margin is even and smooth, like Fig. 12.

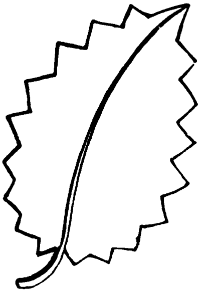
A SER′RATE margin has sharp teeth pointing forward like a saw (see Fig. 13).

FIG. 14.



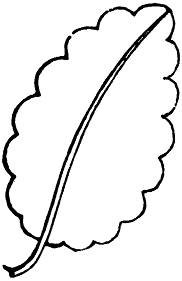
Dentate.

FIG. 15.



Dentate.

FIG. 16.

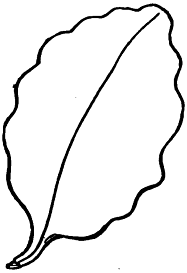


Crenate.

A DEN′TATE margin has sharp teeth pointing outward. Figs. 14 and 15 are different forms of Dentate margin.

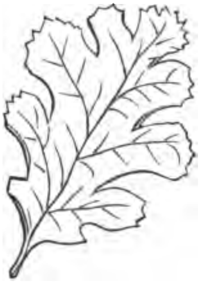
A CRE′NATE margin has broad, rounded notches, like Fig. 16.

FIG. 17.



Repand.

FIG. 18.



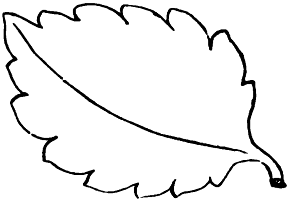
A Lobed Leaf.

In REPAND′ (WAVY) margins the edge curves outward and inward, as in Fig. 17.

Such deep notches as are seen in Fig. 18 form lobes.

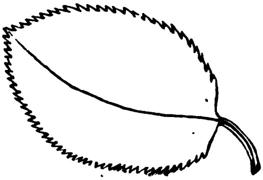
Each of these different kinds of margin varies in many ways, and some of the variations are important

FIG. 19.



Coarsely Serrate.

FIG. 20.

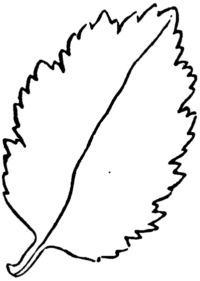


Finely Serrate.

in description. For instance, serrate margins are sometimes COARSELY SERRATE (Fig. 19), FINELY SER-

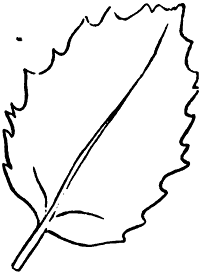
RATE (Fig. 20), DOUBLY SERRATE (Fig. 21), and UNEVENLY SERRATE (Fig. 22).

FIG. 21.



Doubly Serrate.

FIG. 22.



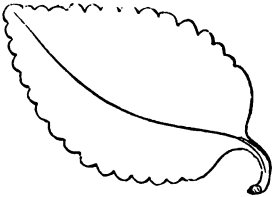
Unevenly Serrate.

Look out for the same kinds of variation among crenate margins. Fig. 23 shows you a FINELY CRENATE margin. Doubly crenate margins are very common.

Dentate margins are coarse, fine, double, and also uneven.

You will sometimes find two kinds of margin on the same leaf. Part of the notches may be serrate and part dentate, and this forms a serrate-dentate margin. If some of the notches are crenate and some serrate, it will be crenate-serrate, and so on.

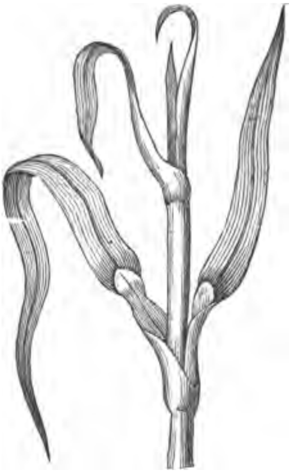
FIG. 23.



Finely Crenate.

In answering the new question, Margin? which you will find in the next schedule, you must look closely for all these different forms, and get familiar with the terms by which they are described.

FIG. 24.



SCHEDULE SECOND, DESCRIBING FIG. 24.

Parts?	Blade, Sheath, Ligule.
Venation?	Parallel-veined.
Margin?	Entire.

EXERCISE VII.

Bases.

The Base of a leaf is its lower or attached end. Bases are

Cor′date (Heart-shaped).—Shaped like a heart, at the base. Fig. 25.

Fig. 25.

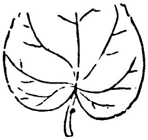


Fig. 26.

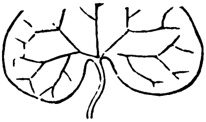
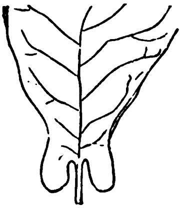


Fig. 27.



Ren′iform*(Kidney-shaped).—Shaped like a kidney. Broader than long. Fig. 26.

Auric′ulate (Ear-shaped).—With small, rounded lobes at the base. Fig. 27.

Fig. 28.

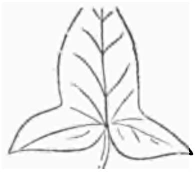


Fig. 29.

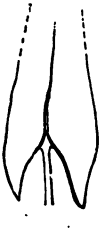


Fig. 30.

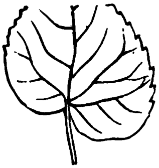
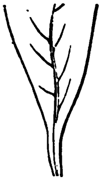


Fig. 31.



Has′tate (Halbert-shaped).—With spreading lobes at the base. Fig. 28.

Sag′ittate (Arrow-shaped).—With sharp lobes at the base pointing backward. Fig. 29.

---

* By some, this term is applied only to the whole leaf.

Oblique′.—With one side of the base larger and lower than the other. Fig. 30.

Tapering.—Where the blade tapers off at the base. Fig. 31.

Fig. 32.

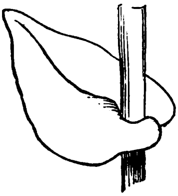


Fig. 33.

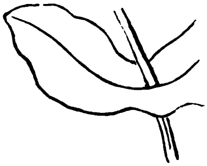
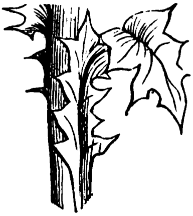


Fig. 34



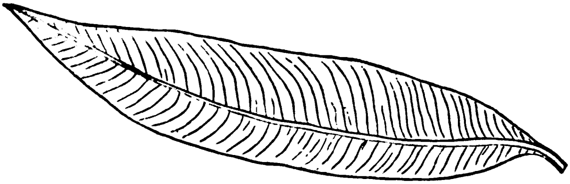
Clasping.—Where the base folds around the stem of the plant. Fig. 32.

Connate′.—Where the bases of two leaves grow together around the plant-stem, as in Fig. 33.

Decur′rent.—Where the lower part of the midrib grows to the plant-stem, as in Fig. 34.

Note.—Children will, of course, get leaves from the same plants, and describe them over and over again as they pass on from schedule to schedule. A few plants will obtrude themselves upon the attention, and each day the pupil will gather leaves from these alone. At first they will have very little enterprise in searching for new specimens, but will be content with whatever is easiest. These will serve perhaps as well as any to illustrate the new character brought out by the new schedule, but the repetition of old observations upon them will require but little effort of the attention. This repetition of observations upon the same varieties of leaves is proper and desirable, but not sufficient for our purpose. As the wealth of varied forms that plants present is to be our means of educating the observation, it is indispensable that our re-

FIG. 35.



SCHEDULE THIRD, DESCRIBING FIG. 35.

Parts?	Blade, Petiole.
Venation?	Feather-veined.
Margin?	Entire.
Base?	Slightly tapering.

The base of Fig. 35 is much less tapering than Fig. 31. You will find all degrees, in this respect, from very blunt to very tapering. You will also be likely to find many leaves to which none of these pictures apply. In such cases you may write, I do not know, in the schedule, and wait till further exercises have shown you how to describe them.

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sources shall be as extensive as possible. Teachers should therefore press beginners and negligent pupils about looking for new specimens. After a little time, such pressing will, in most cases, be unnecessary; for, when the interest and pride of a child are awakened by success in describing plants, he will take increasing pains to find new subjects for description.

EXERCISE VIII.

Apices.

The Apex of a leaf is its top, or free end.

Fig. 36.

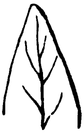


Fig. 37.

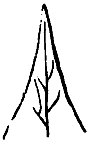


Fig. 38.

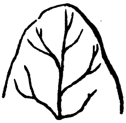


Fig. 39.

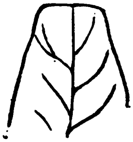
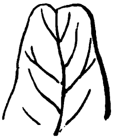


Fig. 40.



The Apex of a leaf may be:

Acute′.—Simply ending with a point. Fig. 36.

Acu′minate.—Ending with a long tapering point. Fig. 37.

Obtuse′.—Blunt. Fig. 38.

Trun′cate.—Cut off at the apex. Fig. 39.

Retuse′.—With the end rounded inward. Fig. 40.

Fig. 41.

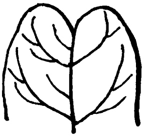


Fig. 42.

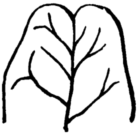


Fig. 43.

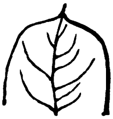
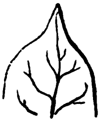


Fig. 44.



Obcor′date.—Heart-shaped at the apex. Fig. 41.

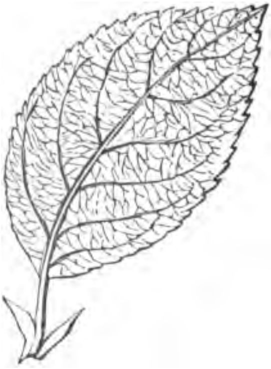
Emar′ginate.—With a small notch at the apex. Fig. 42.

Mu′cronate.—Tipped with a stiff, sharp point. Fig. 43.

Cus′pidate.—Suddenly ending with a sharp, slender point. Fig. 44.

The words acute, acuminate, and obtuse may be used to describe *bases* as well as *apices*, and, when we wish to say that a shape is less acute or less acuminate than Figs. 36 and 37, we may say it is sub-acute or sub-acuminate, as in the schedule to Fig. 45.

FIG. 45.



SCHEDULE FOURTH, DESCRIBING FIG. 45.

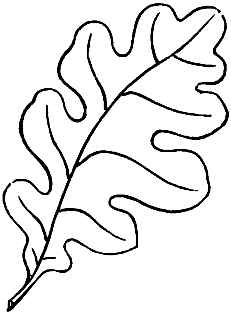
Parts?	*Blade, Petiole, Stipules.*
Venation?	*Net-veined, Feather-veined.*
Margin?	*Serrate.*
Base?	*Obtuse.*
Apex?	*Sub-acute.*

EXERCISE IX.

Forms of Lobes.

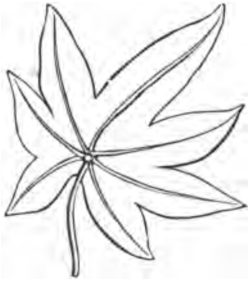
THE most striking difference in lobed leaves is the one seen in contrasting Fig. 46 with Fig. 47. It will be quite enough to ask of young beginners that they report whether the lobes of a leaf are rounded or acute.

FIG. 46.



Rounded Lobes.

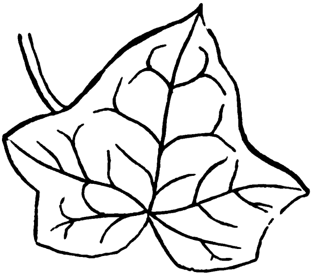
FIG. 47.



Acute Lobes.

But there may be older pupils who could profitably go further in observing the lobes of leaves. They vary much in size and shape, and are rarely all alike upon the same leaf. The lobe at the apex of a leaf is called the *Terminal* lobe, and is usually unlike all the others. The two lobes at the base are called *basal* lobes, and these also are usually unlike all the rest; for any pupils who would desire fuller observations upon lobes, a schedule might be prepared with two additional lines and the two questions, Terminal? and Basal? added to the present one. It might be well in such a case to give the number of lobes upon the leaf, along with their form, in answer to the question Lobes? While the peculiarities of the terminal and basal lobes would be given after these questions.

FIG. 48.



SCHEDULE FIFTH, DESCRIBING FIG. 48.

Parts?	*Blade, Petiole.*
Venation?	*Palmate-veined.*
Margin?	*Lobed.*
Base?	*Cordate.*
Apex?	*Acute.*
Lobes?	*Acute and Sub-acute.*

In dealing with lobed leaves, you will not always find the base and apex so easily described as is Fig. 53, in the schedule. If they give you trouble, you may omit the questions, Base? and Apex?

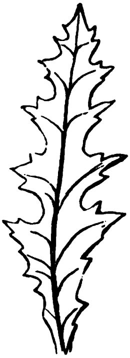
EXERCISE X.

Forms of Sinuses.

The SI'NUS of a leaf is the space left between lobes.

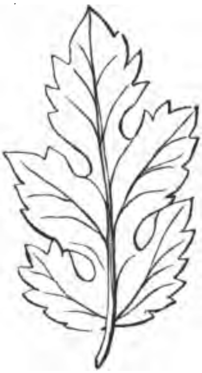
We represent here some of the most usual forms presented by Sinuses, with the terms describing them printed below the pictures.

FIG. 49.



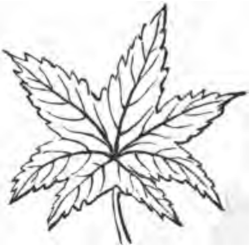
Open Sinus.

FIG. 50.



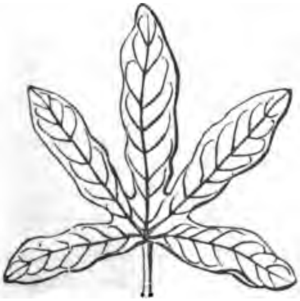
Shut Sinus.

FIG. 51.



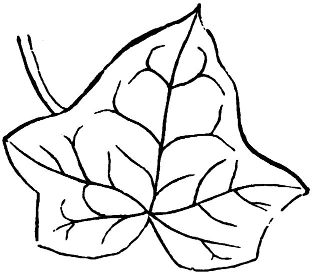
Sharp Sinus.

FIG. 52.



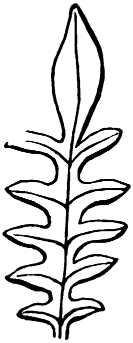
Sharp and deep Sinus.

FIG. 53.



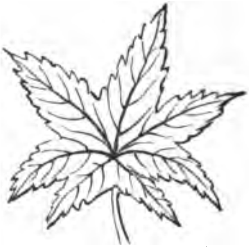
Broad, round, shallow Sinus.

FIG. 54.



Round, deep Sinus.

FIG. 55.



SCHEDULE SIX, DESCRIBING FIG. 55.

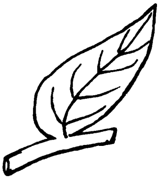
Parts?	Blade, Petiole.
Venation?	Palmate-veined
Margin?	Serrate.
Base?	A broad, open Sinus.
Apex?	Acute.
Lobes?	Acute.
Sinuses?	Sharp, upper ones deep.

NOTE.—It will be observed that our exercises contain none of the descriptions of plants and explanations of their growth which usually make up the text of botanies. These might be

EXERCISE XI.

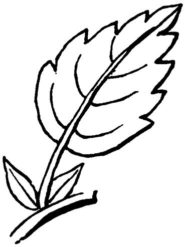
Kinds of Leaves.

Fig. 56.



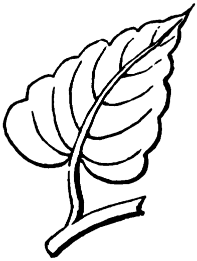
Sessile Leaf.

Fig. 57.



Stipulate and Petiolate Leaf.

Fig. 58.



A Petiolate and Exstipulate Leaf.

A SES′SILE Leaf is a leaf without a petiole.
A STIP′ULATE Leaf is a leaf that has stipules.
A PET′IOLATE Leaf is a leaf that has a petiole.
An EXSTIP′ULATE Leaf is a leaf without stipules.

In Schedule Seven, it will be seen, we have dropped the question Parts? and put Kind? in its place. The words by which you answer this question are very long, but you can soon learn to handle them, and by-and-by you will find them much more convenient in leaf-description than it will be always to give a list of the parts.

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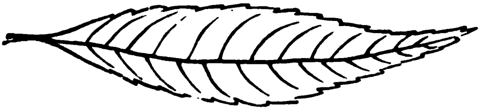
easily given, but it would be a departure from our essential plan. The work before us—the observation of the external characters of plants—is itself extensive, and it can only be well done by making it at first our sole occupation. To observe carefully, to repeat our observations till they are familiar, and to acquire the ready and accurate use of the vocabulary of description, are the only true foundation of a knowledge of botany;

FIG. 59.



SCHEDULE SEVEN, DESCRIBING FIG. 59.

Kind?	Petiolate, Exstipulate.
Venation?	Feather-veined.
Margin?	Serrate.
Base?	Acute.
Apex?	Acuminate.
Lobes?	
Sinuses?	

and we must be careful not to anticipate the work which belongs to a higher stage of the pupil's progress. The accounts of tissues, structures, and functions, add nothing to the understanding of plant-forms, and they afford proper subjects for future exercises in observation, to be given in a second book. What we have presented is eminently adapted to childhood, when sense-impressibility, and curiosity about appearances are strongest, and before the reflective powers are much developed.

The apparent meagreness of these pages is, therefore, intentional. They might easily have been filled with interesting reading matter about plants, but that would have opened the door to lesson-learning and reciting, which is a thing we specially wish to prevent.

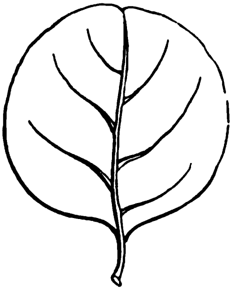
EXERCISE XII.

Shapes of Leaves.

Compare leaves that are not lobed with the first three groups of pictures.

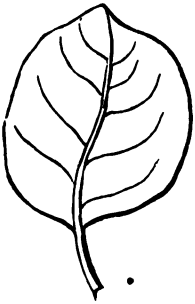
LEAVES THAT ARE BROADEST IN THE MIDDLE.

Fig. 60.



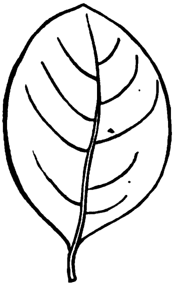
Orbic′ular.

Fig. 61.



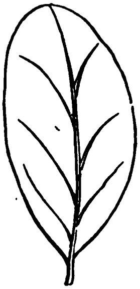
Rotun′date.

Fig. 62.



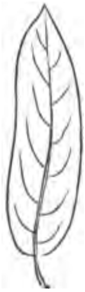
Broadly elliptical.

Fig. 63.



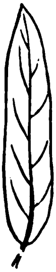
Elliptical.

Fig. 64.



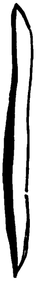
Oblong.

Fig. 65.



Linear.

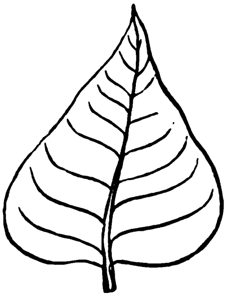
Fig. 66.



Acic′ular.

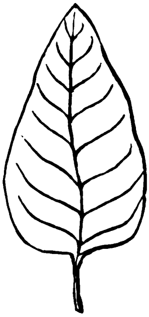
LEAVES THAT ARE BROADEST AT BASE.

Fig. 67.



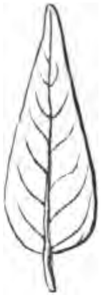
Del′toid.

Fig. 68.



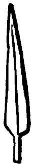
Ovate.

Fig. 69.



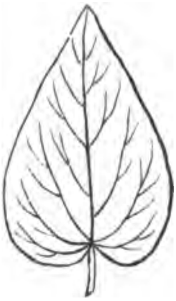
Lanceolate.

Fig. 70.



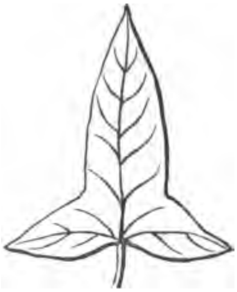
Awl-shaped.

Fig. 71.



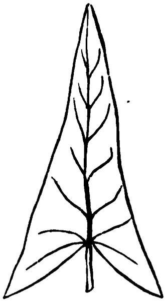
Cordiform.

Fig. 72.



Hastate.

Fig. 73.

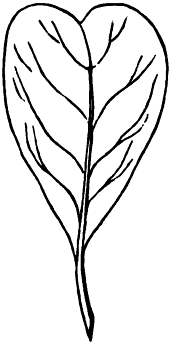


Sagittate.

Some of the names here applied to the whole leaf have already been used to describe a part of a leaf. For instance, among bases we had the heart-shaped base, and now a particular leaf-form is said to be heart-shaped. But it will soon be seen that heart-shaped bases may occur in leaves of very various forms, though there is one general form in which the entire leaf resembles a heart, and is therefore said to be cordate. So the base of a leaf may look like an arrow, while the rest of it is very unlike an arrow. The apex may be truncate or obcordate, or any other form rather than the acute ending of an arrowshaped leaf. Follow the order of the schedule carefully in your descriptions till you begin to grow familiar with varying leaf-forms, and soon all appearance of confusion in the use of words will be at an end.

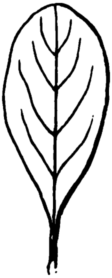
LEAVES THAT ARE BROADEST AT THE APEX.

FIG. 74.



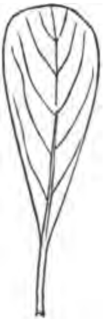
Obcordiform.

FIG. 75.



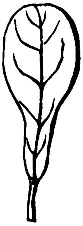
Obo′vate.

FIG. 76.



Oblan′ceolate.

FIG. 77.

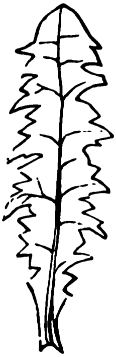


Spath′ulate.

Do not expect to find an exact reproduction in Nature of the forms pictured in the book. You are simply to see which of the pictures your leaf is nearest like, and give it the name or the combination of names which the comparison seems to justify.

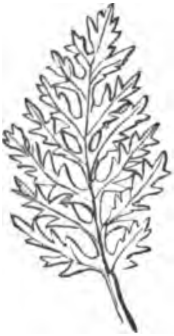
There are, of course, many leaves that you will not at first be able to describe. But if you find a very puzzling leaf, to which the schedule does not seem to apply, you may compare it with the following pictures. Perhaps it will be like one of these, and if so, if you cannot describe it, you can at least learn what to call it. If it is not like any of these pictures, it will be best to postpone its study for the present. By-and-by you will know better how to manage it.

Fig. 78.



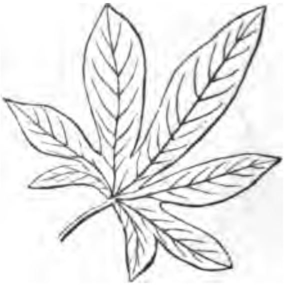
Runcinate.

Fig. 79.



Bipinnatifid.

Fig. 80.



Pedate.

A Run′cinate leaf is a lobed feather-veined leaf, in which the lobes point backward toward the base. Fig. 78.

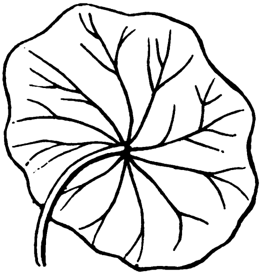
Bipinnat′ifid leaves are formed when a deeply-lobed feather-veined leaf has its lobes again lobed, as in Fig. 79.

A Ped′ate leaf is a lobed palmate-veined leaf, in which the lobes at the base are lobed again, and give the leaf a look like the foot of a bird. Fig. 80.

Curled leaves (Fig. 81) are formed by a spreading of the border of the blade.

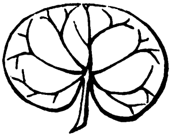
Fig. 81.

Fig. 82.



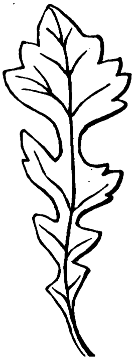
Peltate.

Fig. 83.



Kidney-shaped.

Fig. 84.



Lyrate.

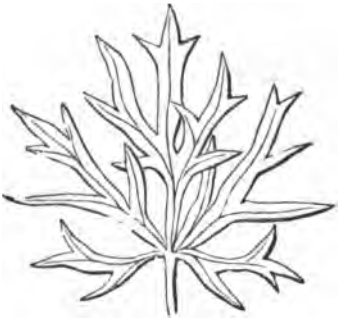
Peltate leaves are round, and have the petiole attached near the middle of the under surface of the blade. Fig. 82.

A Kidney-shaped leaf is short and broad, with a rounded apex and heart-shaped base. Fig. 83.

A Lyrate leaf is a lobed feather-veined leaf, with the terminal lobe much larger than the others. Fig. 84.

Laciniate leaves are so named because they look as if they had been gashed with scissors. Fig. 85 is an example of such a leaf.

Fig. 85.



Schedule Seven, describing Fig. 85.

Kind ?	*Petiolate, Exstipulate.*
Venation ?	*Palmate-veined.*
Margin ?	
Base ?	
Apex ?	
Lobes ?	*Acuminate.*
Sinuses ?	*Sharp, deep.*
Shape ?	*Laciniate.*

EXERCISE XIII.

Petioles, Surfaces, and Colors.

THE following schedule has three new questions added to it. The first is Petiole? The shape of the petiole, whether round, roundish, or half-round, should be observed, and written down. And if it be remarkable for its length or shortness, if it be unusually limber, or unusually stiff, you must mention these peculiarities about it.

COLOR? To this question the answer is easy. Leaves are sometimes light green, sometimes dark-green; and sometimes the upper surface is one color, and the lower another. There are spotted and striped leaves, and some leaves have a brownish or reddish tinge. All these things are to be noted when you see them.

SURFACE? Observe whether the surface of a leaf has hairs or not. If it has hairs, write *hairy* after this question; but, if it has no hairs, write *glabrous*, which means free from hairs.

Again, surfaces are either *smooth* or *rough*, observe which, and write the result in the schedule.

Some leaves have a very *shiny* surface, and some are very *dull*, and these differences should be observed, and written down; but these qualities need not be noted unless they are strongly marked.

These characters cannot be conveniently represented by pictures, but they are readily seen in actual leaves. Feeling sure that you can easily make them out, we have not attempted to describe a leaf in schedule eight.

The schedule is now made up of the following questions:

SCHEDULE EIGHT.

Kind?	
Venation?	
Margin?	
Base?	
Apex?	
Lobes?	
Sinuses?	
Shape?	
Petiole?	
Color?	
Surface?	

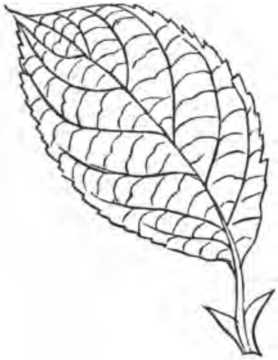
NOTE.—While in a book we must present one definite order of exercises, it is well if teachers use their own judgment in adhering to this order. Often, doubtless, much will be gained by judicious deviation. There are minds that demand variety, or their interest flags; and the minds of children, especially, are liable to grow weary of continued attention to one class of objects. Before proceeding with the exercises upon compound leaves, it may, therefore, be advisable to turn to the chapter upon the Inflorescence, or that upon the Flower, and occupy a little time with the opening exercise in which the names of parts are brought before the mind. The identification and naming of the parts of the flower will be easier to most children than the discrimination of simple and compound leaves; while dealing with another and more showy portion of the plant will stimulate the attention.

The use of schedule eight should, however, still be kept up, and, after a little while, the pupil will come back to the study of compound leaves with a fresh relish for the subject.

EXERCISE XIV.

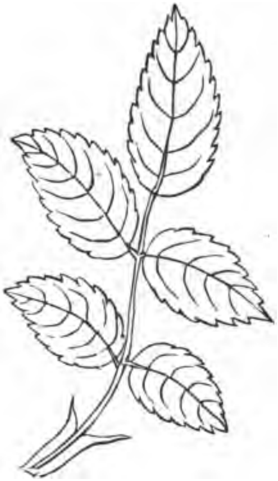
Simple and Compound Leaves.

FIG. 88.



Simple Leaf.

FIG. 89.



Compound Leaf.

SIMPLE LEAVES have only one blade.

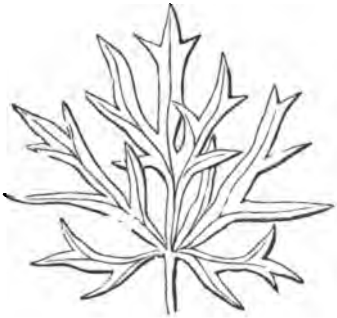
COMPOUND LEAVES consist of several distinct blades, called leaflets. You may know leaflets from lobes by their being entirely separate from each other.

UP to this time I suppose that pupils have described leaflets as leaves; but they must now be careful not to make this mistake. Let them confine themselves to simple leaves in using schedule eight, and write *simple leaf* upon it, to show that they have considered the matter.

It is sometimes a very nice point to decide between a deeply-lobed leaf and a compound leaf. If confusion at first arises, it must be patiently borne. We might add to the above definition of a compound leaf, that leaflets are jointed to the stalk, while the divisions called lobes never are. Such a statement would save trouble at first, but it would make greater trouble in the end. The truth is, that deeply-lobed leaves pass by insensible gradations into compound leaves, and compound leaves have their leaflets in all stages of connection with the common stalk, from a complete continuation of one into the other, up to a perfectly-jointed connection.

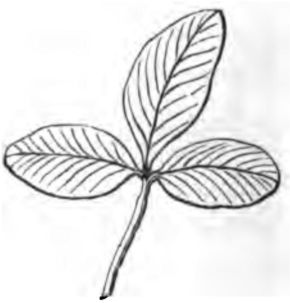
If the green matter of a leaf is continuous around the veins and along the ribs, however narrow the strip may be, it is quite correct to call such a specimen a simple leaf.

Fig. 90.



Lobes.

Fig. 91.



Leaflets.

There is no way, for the pupil, out of this difficulty except through a course of careful observation. Doubtless many mistakes will be made ; but mistakes are very useful in education.

EXERCISE XV.

Parts of Compound Leaves.

Fig. 92.

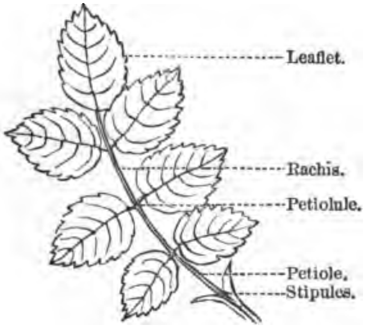


Fig. 93.

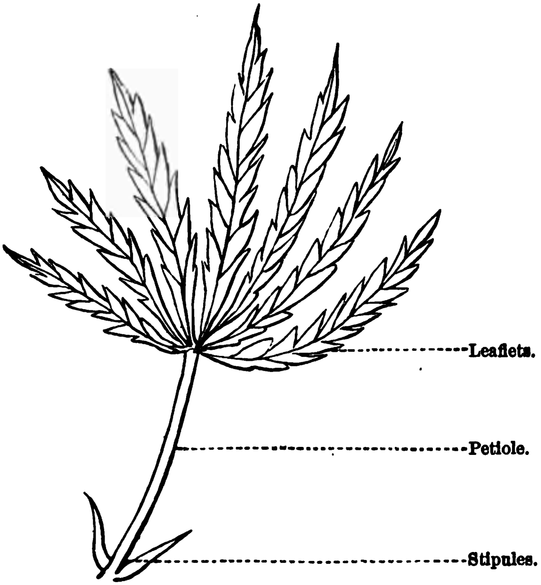
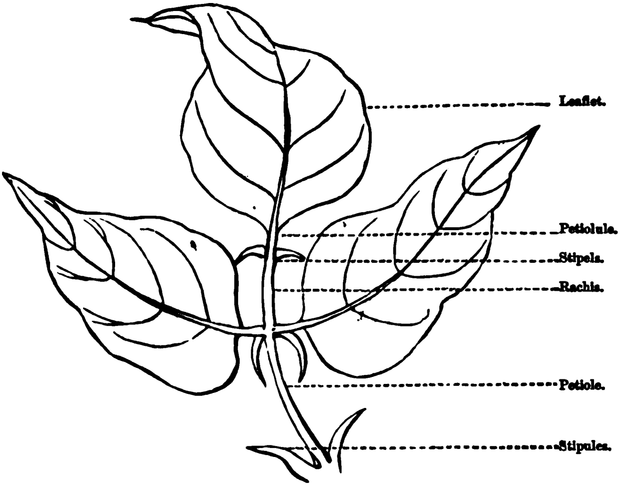


FIG. 94.



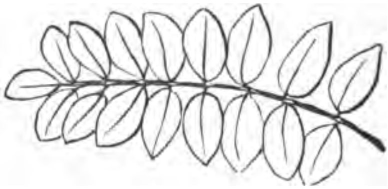
LEAFLET.—One of the blades of a compound leaf.

PET′IOLULE.—The stem of a leaflet.

STI′PELS.—The stipules of leaflets.

RA′CHIS.—The continuation of the petiole to which leaflets are attached.

FIG. 95.



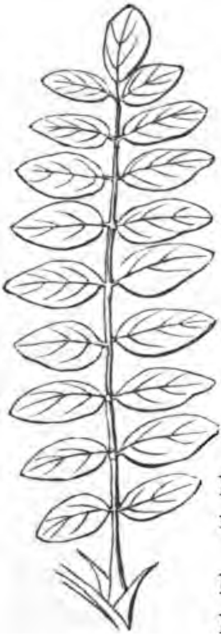
SCHEDULE NINE, DESCRIBING FIG. 95.

Parts.	Rachis, Petiole, Leaflets.
No. of Leaflets.	17.

EXERCISE XVI.

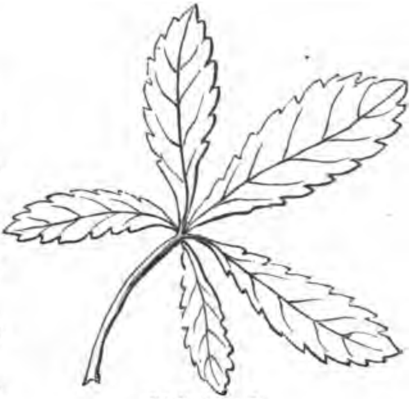
Pin'nate and Dig'itate Leaves.

FIG. 96.



Pinnate Leaf.

FIG. 97.



Digitate Leaf.

In PINNATE Leaves, the leaflets grow along the sides of the rachis.

In DIGITATE Leaves, the leaflets all start together from the petiole.

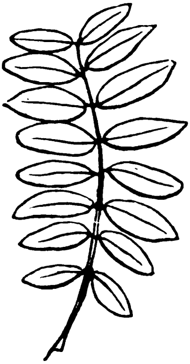
SCHEDULE TEN, DESCRIBING FIG. 97.

Parts?	Petiole Leaflets.
No. Leaflets?	5.
Kind?	Digitate.

EXERCISE XVII.

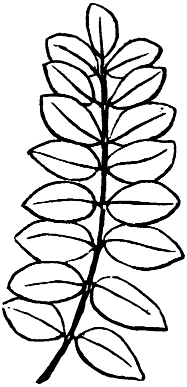
Varieties of Pinnate Leaves.

Fig. 98.



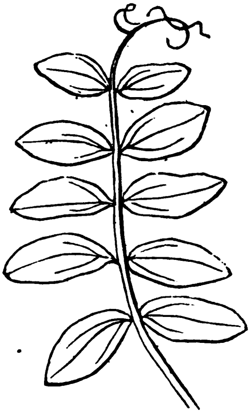
Abruptly Pinnate.

Fig. 99.



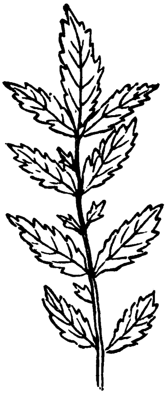
Unequally Pinnate.

Fig. 100.



Cirrose.

Fig. 101.



Interruptedly Pinnate.

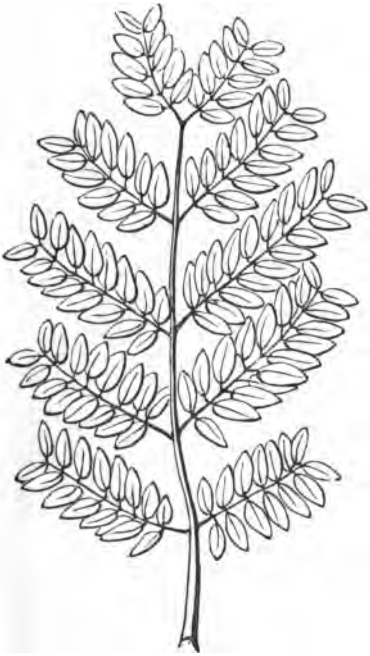
Abruptly Pinnate.—When the leaf terminates in a *pair* of leaflets. Fig. 98.

Unequally Pinnate.—When the leaf terminates in an *odd*, or single, leaflet. Fig. 99.

Cirrose.—When the rachis ends in slender branching curls, called *tendrils*. Fig. 100.

Interruptedly Pinnate.—When the leaflets are alternately large and small. Fig. 101.

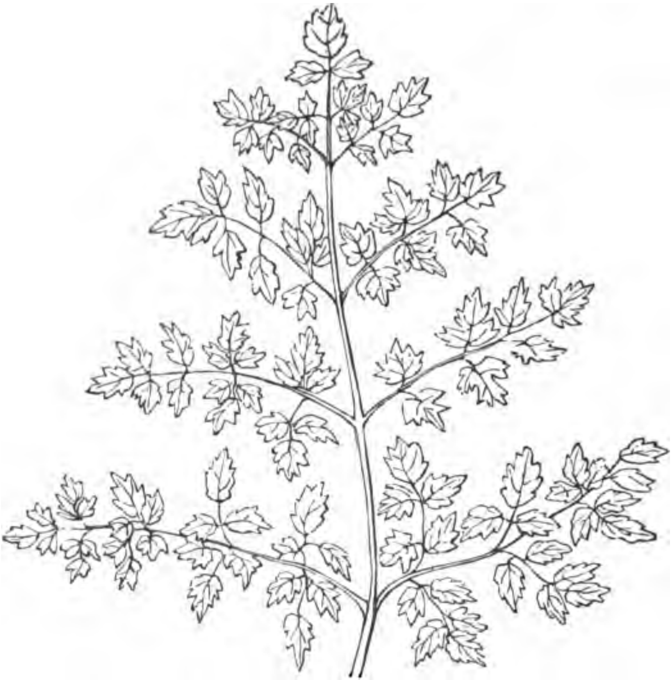
Fig. 102.



Twice Pinnate.

Twice Pinnate.—When the petiolule is continued as a rachis which bears the leaflets.

FIG. 108.



Thrice Pinnate.

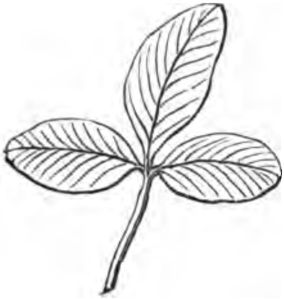
THRICE PINNATE.—When the leaflets are borne upon a third rachis, branching off from the second.

EXERCISE XVIII.

Varieties of Digitate Leaves.

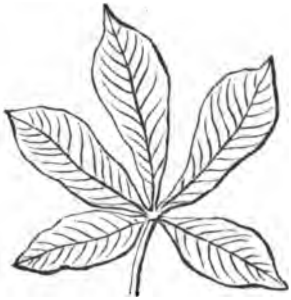
THREE-FINGERED.—A digitate leaf with three leaflets.

FIG. 104.



Three-fingered.

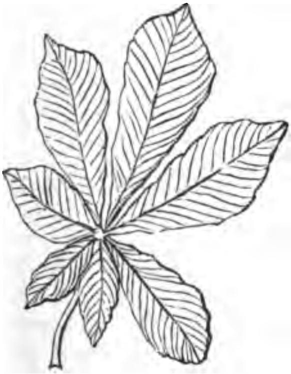
FIG. 105.



Five-fingered.

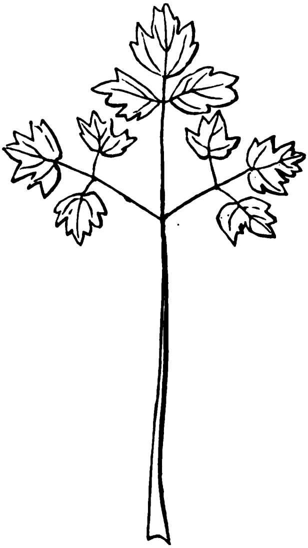
FIVE-FINGERED.—A digitate leaf with five fingers or leaflets.

FIG. 106.



Seven-fingered.

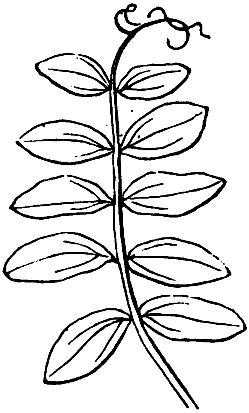
FIG. 107.



Twice Three-fingered.

SEVEN-FINGERED.—A digitate leaf with seven fingers or leaflets. Fig. 106.

FIG. 108.



SCHEDULE ELEVEN, DESCRIBING FIG. 108.

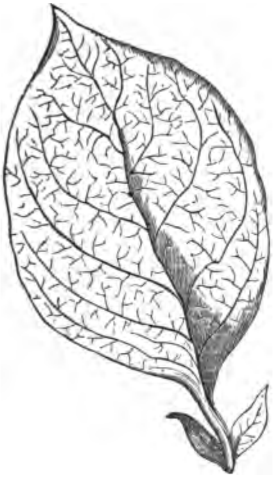
Parts?	*Petiole, Rachis, Leaflets.*
No. Leaflets?	*10.*
Kind?	*Pinnate.*
Variety?	*Cirrose.*

NOTE.—This is the last leaf-schedule. With the next chapter we begin the study of the stem. But we must still in some way pursue the study of leaf-forms, if we would render permanent the knowledge we have already acquired. An observation is by no means a mental possession as soon as it is made. True knowledge is always a growth requiring *time;* and observations have not only to be *made*, but to be *repeated*, and

EXERCISE XIX.

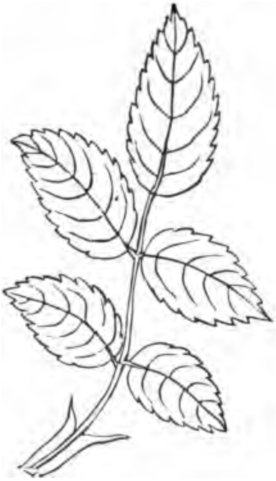
Forms of Stipules.

FIG. 109.



Free Stipules.

FIG. 110.

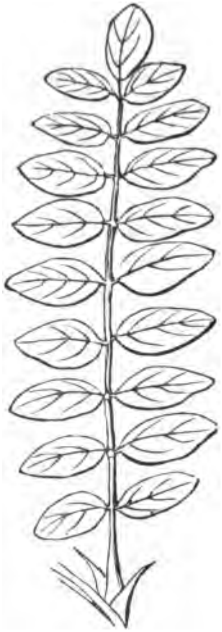


Adnate Stipules.

STIPULES are:
FREE.—When not united with any other part.
ADNATE.—When they grow to the petiole.

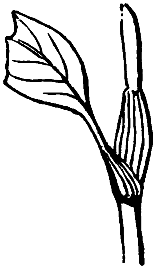
the facts knit into their places, to make them reliable mental possessions. Understanding a thing is but the first step toward its real acquirement. A succession of frequent observations is necessary to induce familiarity with objects, and there must also be a recurrence to them—a revival of impressions after considerable intervals of time. It is possible to have an *intense* familiarity with things observed, by occupying the whole consciousness with them for a short time, but effects thus produced are not lasting. We shall, therefore, continue our observations of leaves, and record them upon the stem-schedule. Pupils who have been diligent in the use of the

FIG. 111.



Prickly Stipules.

FIG. 112.



Ochreate Stipules.

PRICKLY.—Like thorns.

OCHREATE.—When they form a sheath around the stem.

If any of the distinctions among compound leaves bother very young pupils, let the observation of such be omitted for the present.

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preceding schedules, ought now to be able to describe leaves without their aid. Exercise XX. consists of two descriptions, in which the schedule questions are omitted. The order of description which has all along been followed will naturally have become the order of thought with pupils, and the prompt-

EXERCISE XX.

FIG. 113.

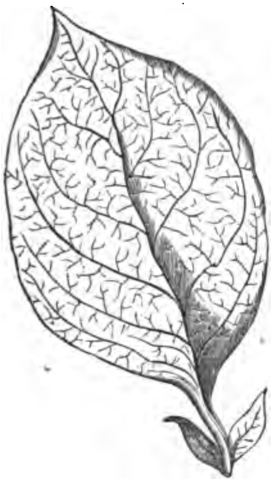
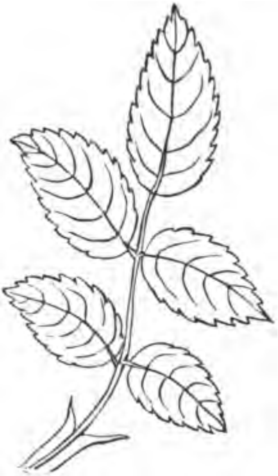


FIG. 114.



Leaf (Fig. 113).—Simple, petiolate, stipulate, net-veined, feather-veined, entire, abruptly acuminate, broadly oval; *petiole*, short, bordered by the blade; *stipules*, free.

Leaf (Fig. 114).—Compound, petiolate, stipulate, unequally pinnate, number of leaflets, 5; *leaflets*, petiolate, feather-veined, serrate, ovate; *stipules*, adnate.

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ing of questions is now unnecessary. They have answered their purpose if they have led to a knowledge of the parts of leaves and their most important modifications of form. When this is done, it will be much more important that the pupil be unassisted in making descriptions than that he be always methodical and correct.

For pupils that are old enough to punctuate their descriptions, the following rule will be useful:—1. Separate adjectives relating to the same noun, by commas; 2. Parts of the same organ, by semicolons; 3. Distinct organs, by a period.

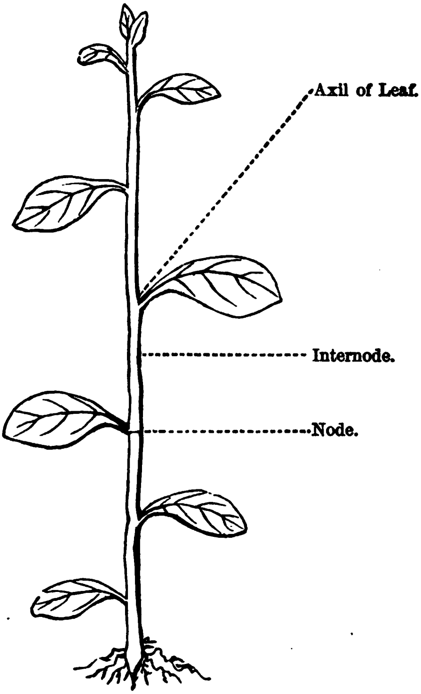
CHAPTER II.

THE STEM.

EXERCISE XXI.

Parts of the Stem, and Leaf Axil.

FIG. 115.



Nodes and Internodes.

Fig. 116.

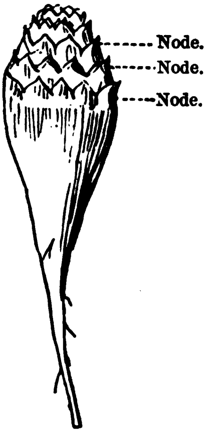
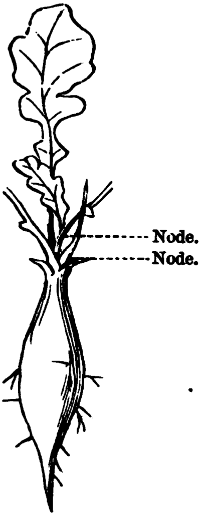


Fig. 117.



Node.—The point on the stem from which leaves are given off.

Internode.—The portion of the stem between two nodes.

Leaf Axil.—The point at the upper side of the leaf where it joins the stem.

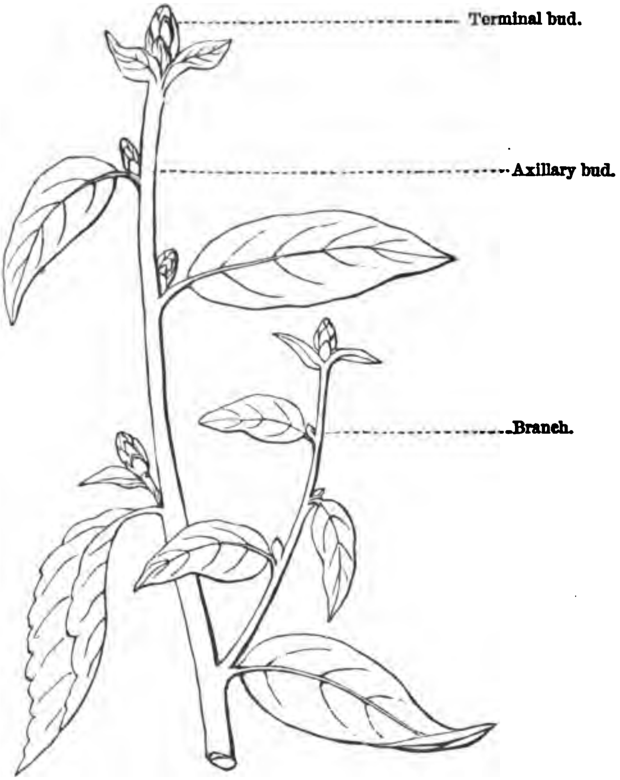
Note.—Children will easily find the nodes and internodes of most stems, but they should not, therefore, hurry past this exercise without tracing the successive internodes of many stems from the root upward. The teacher should also see that a clear idea is gained of the axil of a leaf.

If Figs. 116 and 117 are not intelligible to beginners, and the parts of short stems like these are distinguished with difficulty, let them be passed over, as the coming exercises are not dependent upon these discriminations. But, for those who can make them out, they will be profitable.

EXERCISE XXII.

Appendages of the Stem.

FIG. 118.

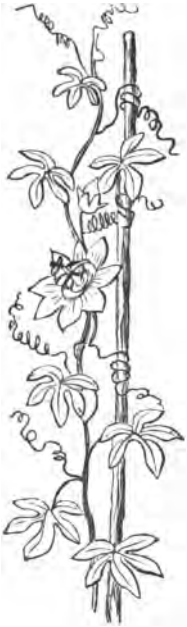


TERMINAL BUD.—The bud at the end of the stem.

AX′ILLARY BUD.—The bud in the axil of a leaf.

BRANCH.—A stem which grows out of an axillary bud.

FIG. 119.



SCHEDULE TWELVE, DESCRIBING FIG. 119.

Parts?	*Nodes, Internodes.*
Appendages?	*Leaves, Tendrils, Flowers.*

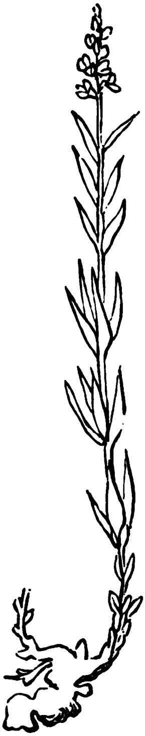
LEAF.—Petiolate, exstipulate, palmate-veined, 5-lobed, broad as long; lobes rounded, entire; sinuses deep, round; *petiole* long, slender.

The appendages of the stem (Fig. 118) are leaves, buds, and branches. The terminal bud continues the growth of the main stem. Axillary buds give rise to branches, or secondary stems.

EXERCISE XXIII.

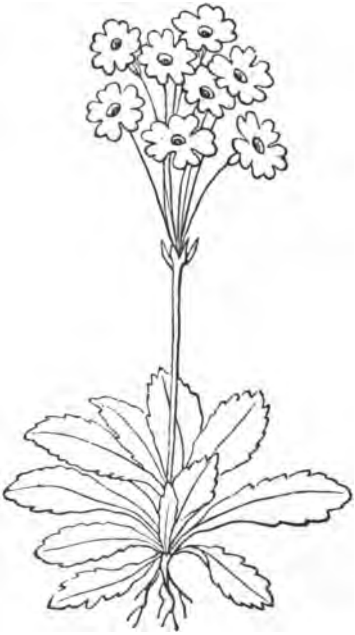
Position of Leaves.

FIG. 120.



Stem Leaves.

FIG. 121.



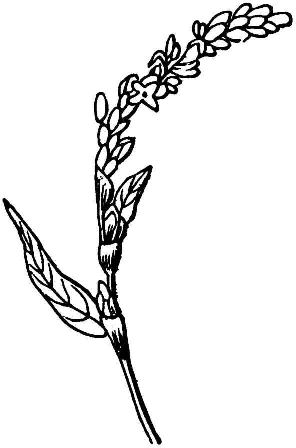
Radical Leaves.

STEM leaves grow along the stem.

RADICAL leaves start close to the ground, or below its surface.

NOTE.—The term *radical* would seem to imply that the leaves spring from roots, which is not the case, as shown in Fig. 117.

FIG. 122.



SCHEDULE THIRTEEN, DESCRIBING FIG. 122.

Appendages?	Leaves, Flowers.
Leaf-position?	Cauline.

LEAF.—Simple, sessile, feather-veined, entire, lanceolate; *stipule*, ochreate.

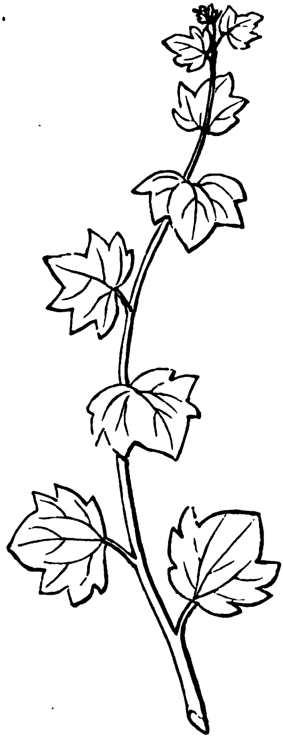
The question, Parts? is now dropped, because it is answered in giving the position of the leaves. To say that leaves are *cauline* is to say that the stem is composed of both nodes and internodes, while, if the stem has radical leaves only, there are no internodes.

NOTE.—When the nodes of a stem are distinctly jointed, when they are swollen and watery (tumid), when they are hairy, or when of a different color from the internodes, they give a peculiar aspect to the plant, and pupils should be en-

EXERCISE XXIV.

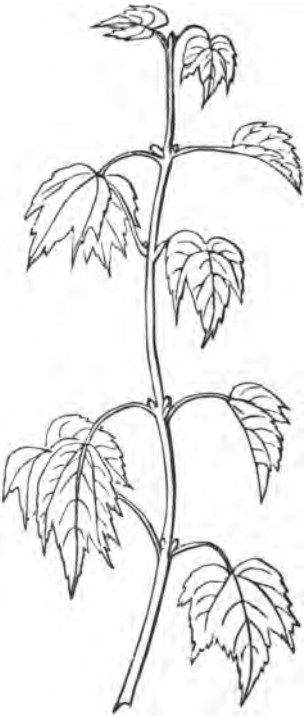
Arrangement of Leaves on the Stem.

FIG. 123.



Alternate Leaves.

FIG. 124.



Opposite Leaves.

ALTERNATE LEAVES.—Leaves are alternate on the stem when there is but one at each node, as in Fig. 123.

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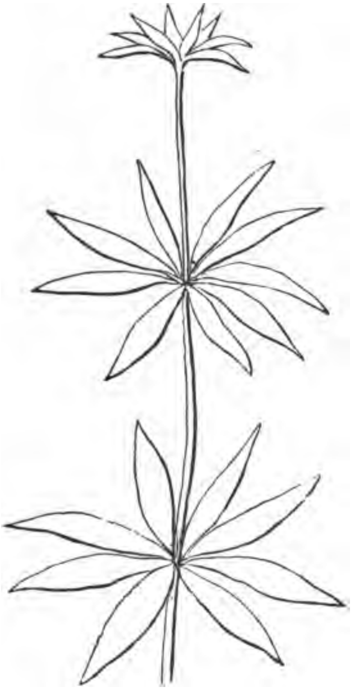
couraged to record such facts upon the schedule. Very long or very short internodes, and other noticeable peculiarities, should

Opposite Leaves.—When two leaves grow opposite each other, we call it the *opposite* arrangement. Fig. 124.

Fig. 125.



Whorled Leaves.

Whorled Leaves.—When there are more than two leaves at a node, we say the leaves are whorled.

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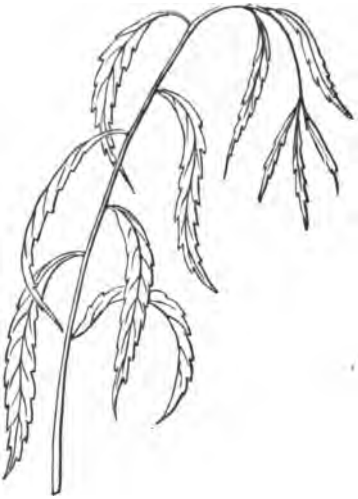
be stated. A word or two at the bottom or back of the schedule, as, nodes tumid, or, internodes very long, is all that is requisite. Brevity and precision of statement should always be insisted upon.

Fig. 126.



Schedule Fifteen, describing Fig. 126.

Appendages?	*Leaves.*
Leaf-position?	*Cauline.*
Leaf-arrangement?	*Alternate.*

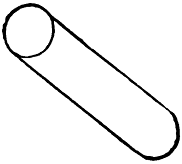
The Leaf.—Sessile, feather-veined, serrate, lanceolate.

Note.—Leaf-position and leaf-arrangement pertain as much to the leaf as to the stem, but observations concerning them could not be properly made until something was known of the stem. When the pupil becomes familiar with these characters, it will, perhaps, be more appropriate to notice them in the leaf-description than in the stem-description.

EXERCISE XXV.

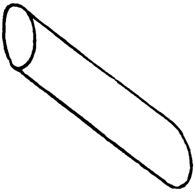
Shapes of Stems.

FIG. 127.



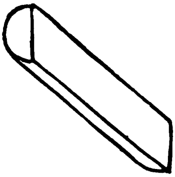
Rounded.

FIG. 128.



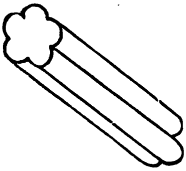
Compressed.

FIG. 129.



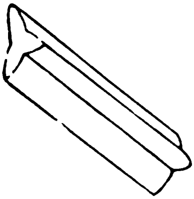
Half-rounded.

FIG. 130.



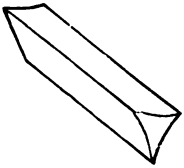
Fluted.

FIG. 131.



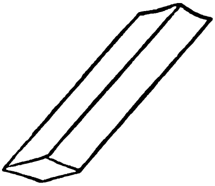
Acute-angled.

FIG. 132.



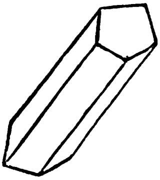
Triangular.

FIG. 133.



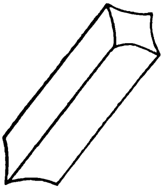
Square.

FIG. 134.



Five-sided.

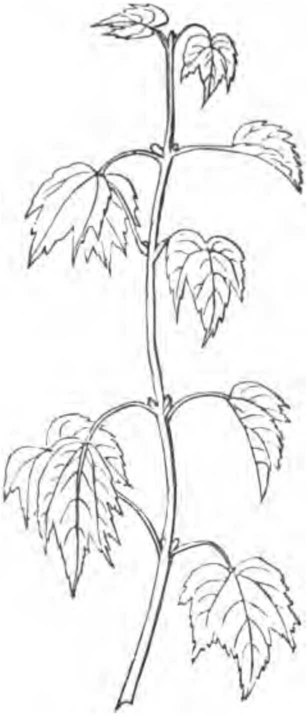
FIG. 135.



Four-angled.

These are by no means all the shapes, nor the precise shapes that stems assume, but their forms will most commonly be found to approach very nearly to some of these outlines. If any forms occur that are so widely different from the pictures as to perplex the pupil, he will consult the teacher.

FIG. 136.



SCHEDULE SIXTEEN, DESCRIBING FIG. 136.

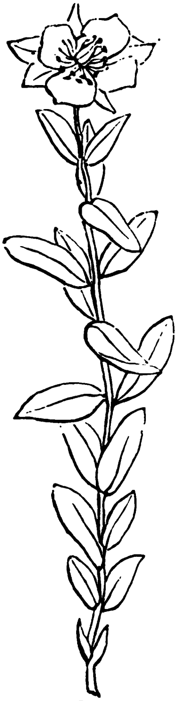
Appendages?	*Leaves, Buds.*
Leaf-position?	*Cauline.*
Leaf-arrangement?	*Opposite.*
Shape?	*Round.*

Leaf.—Petiolate, exstipulate, palmate-veined, serrate, base cordate, 5-lobed, terminal lobe acuminate, leaf broader than long.

EXERCISE XXVI.

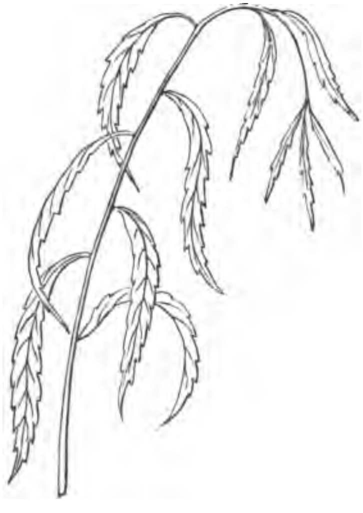
Attitude of Stems.

Fig. 137.



Erect.

Fig. 138.

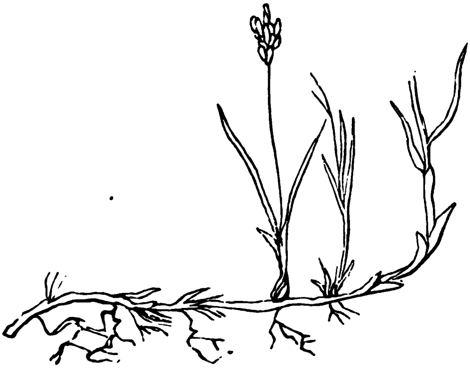


Drooping.

Erect stems stand upright.

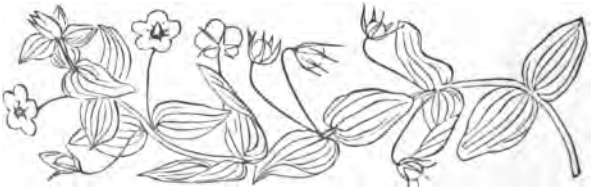
Drooping stems are weak, and bend over.

FIG. 139.



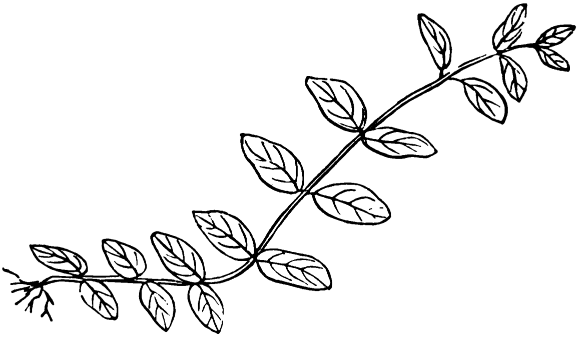
Creeping.

FIG. 140.



Trailing.

FIG. 141.



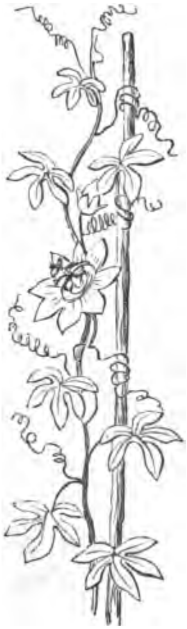
Ascending.

CREEPING stems lie along or below the surface of the ground, and send down roots from their nodes.

TRAILING stems are weak, and lie loosely along the ground. Fig. 140.

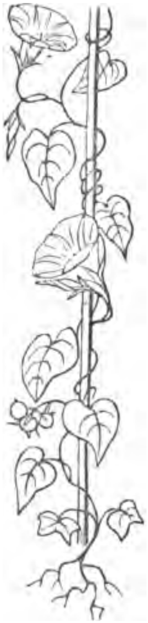
ASCENDING stems stand slanting. Fig. 141.

FIG. 142.



Climbing.

FIG. 143.



Twining.

CLIMBING stems are weak, and cling by tendrils to the objects about them.

TWINING stems are too weak to stand alone, and support themselves by winding around other stems.

SCHEDULE SEVENTEEN, DESCRIBING FIG. 143.

Appendages?	*Leaves, Flowers.*
Leaf-position?	*Cauline.*
Leaf-arrangement?	*Alternate.*
Shape?	*Round.*
Attitude?	*Twining.*

LEAF.— Simple, petiolate, exstipulate, feather-veined, entire, cordate, sub-acuminate.

EXERCISE XXVII.

Color, Surface, Size, Structure.

COLOR.—Stems may be spotted, striped, green, brown, red, or purple.

SURFACE.—The surface of stems, like that of leaves, is smooth, rough, shiny, dull, hairy, and glabrous.

SIZE.– Stems may be high or low, slender or thick, and it is easy to determine these points.

STRUCTURE.—To find out the structure of a stem, you must break it, and observe first whether it is *hollow* or *solid.* Next examine it to ascertain if it have any tenacious threads; these are *woody* fibres, and, when present, they help to make the stem hard and tough. It is then called a WOODY stem. But, if it is soft and brittle, it is an HERBACEOUS stem. The stem schedule consists now of the following questions:

SCHEDULE EIGHTEEN.

Appendages?	
Leaf-position?	
Leaf-arrangement?	
Shape?	
Attitude?	
Color?	
Surface?	
Size?	
Structure?	

NOTE.—In schedule eighteen, as in schedule nine, no picture is described, because two of the questions now added, viz., Color? and Structure? relate to features that cannot be easily represented in a picture, while size and surface, as seen in nature, are so unlike pictorial presentations, that an example given here would be but a poor guide in schedule practise. The descriptive terms used in answering these questions are so familiar as not to need illustration.

CHAPTER III.

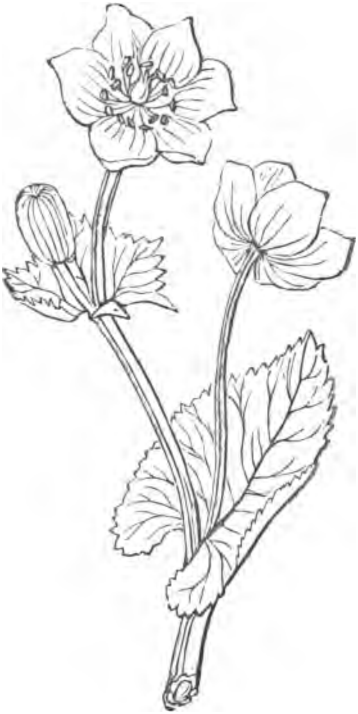
THE INFLORESCENCE.

Inflorescence.—The way flowers are placed upon plants is called their *inflorescence.*

EXERCISE XXVIII.

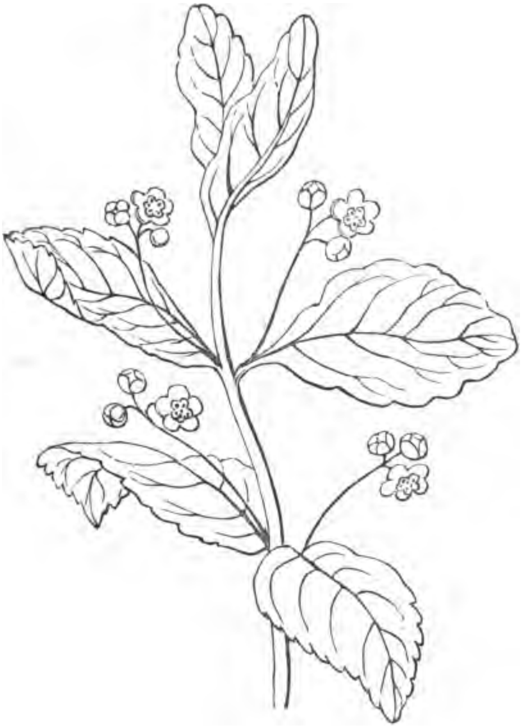
Solitary and Clustered Inflorescence.

Fig. 144.



Solitary Inflorescence.

FIG. 145.



Clustered Inflorescence.

SOLITARY INFLORESCENCE is where only one flower grows upon a flower-stem. Fig. 144.

CLUSTERED INFLORESCENCE is where several flowers grow from the same flower-stem.

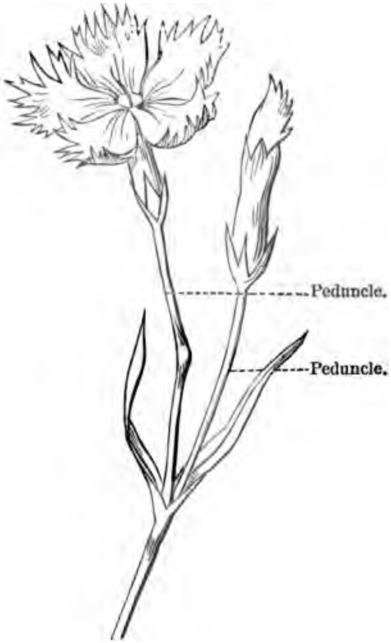
Flowers, or flower-clusters without stems, are said to be *sessile*.

NOTE.—This and the following exercise should be dealt with in the same manner as the first exercises in the chapters upon the leaf and stem.

EXERCISE XXIX.

Parts of the Inflorescence.

FIG. 146.



PEDUN'CLE.—The stem of a solitary flower, or of a flower cluster.

BRACTS.—The small leaves of a flower-cluster on the peduncle, or raĉhis.

IN'VOLUCRE.—A whorl of bracts.

PED'ICEL.—One of the flower-stems in a cluster.

BRACT'LETS.—Very small leaves growing upon pedicels.

FIG. 147.

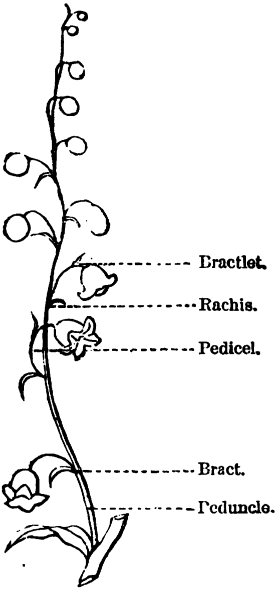


FIG. 148.

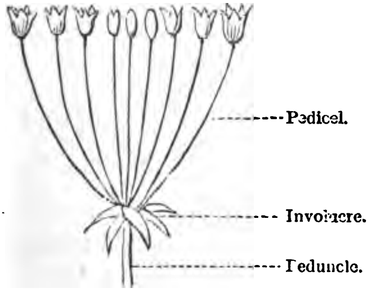
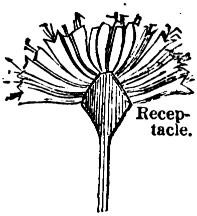


FIG. 149.



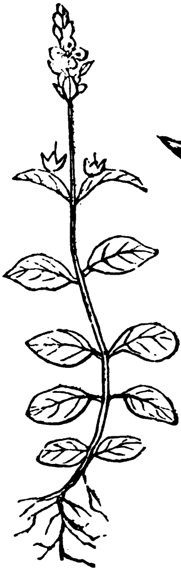
RA'CHIS.—The continuation of a peduncle, from which flowers branch off.

RECEP'TACLE.—The top of a peduncle, from which several flowers start together.

EXERCISE XXX.

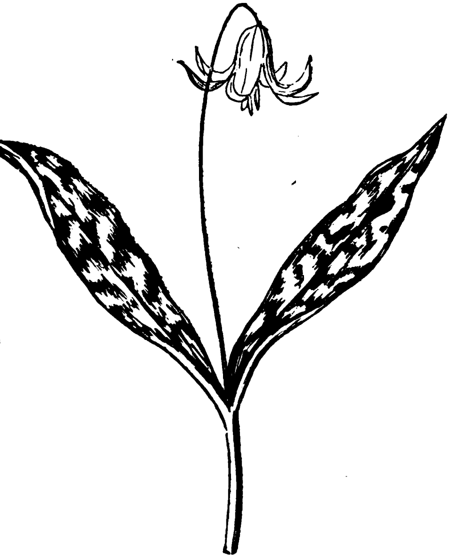
Attitude of Inflorescence.

FIG. 150.



Erect.

FIG. 151.



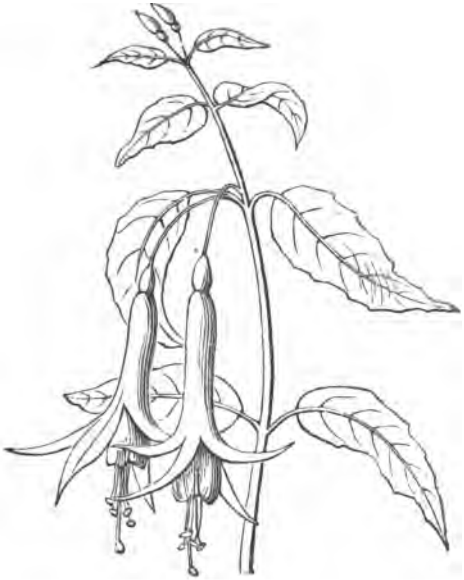
Nodding.

ERECT.—Upright.
NODDING.—Bending over.

NOTE.—Many of the characters already noted as belonging to the stem of a plant, belong also to the peduncle. Its color, surface, shape, length, limpness, twist, and curvature, may be recorded in connection with the attitude in the same terms as are used in stem-descriptions.

Some of the statements in the description of Fig. 152 are to be compared with the living plant, and not the picture.

FIG. 152.



Pendulous.

PEN'DULOUS.—Hanging down.

SCHEDULE EIGHTEEN, DESCRIBING FIG. 152.

Parts?	*Peduncle, Flower.*
Attitude?	*Pendulous.*

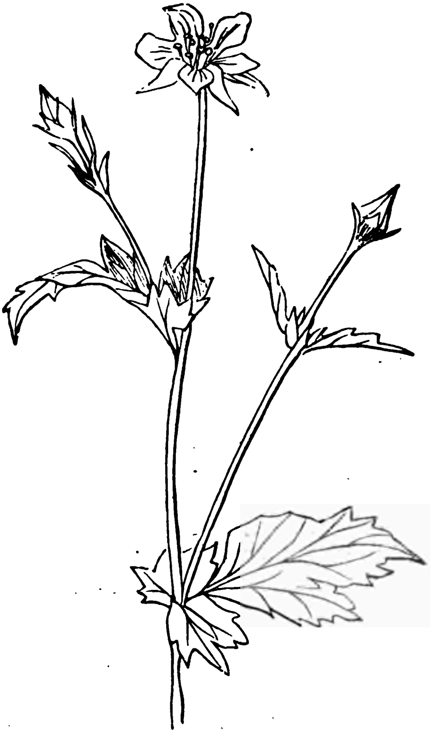
LEAF.— Simple, petiolate, exstipulate, feather-veined, irregularly-dentate, ovate-acuminate, green, smooth, cauline, opposite.

STEM.—Round, slightly bending, reddish brown, smooth, slender, solid, woody.

EXERCISE XXXI.

Solitary Terminal and Axillary Inflorescence.

FIG. 153.

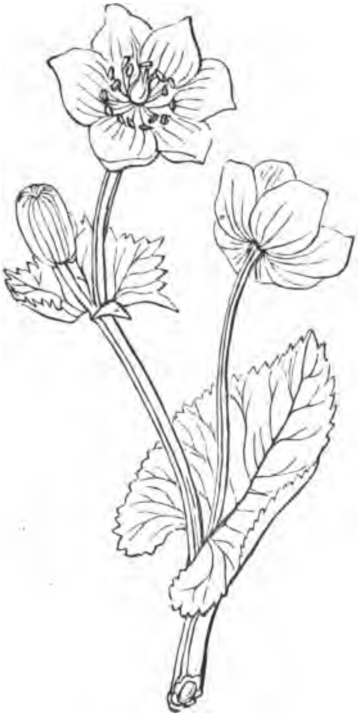


Solitary Terminal.

An inflorescence is SOLITARY TERMINAL when the stem, or branch, ends in a single flower.

The presence of nodes upon ordinary stems distinguishes them from flower-stems or peduncles.

FIG. 154.



Solitary Axillary.

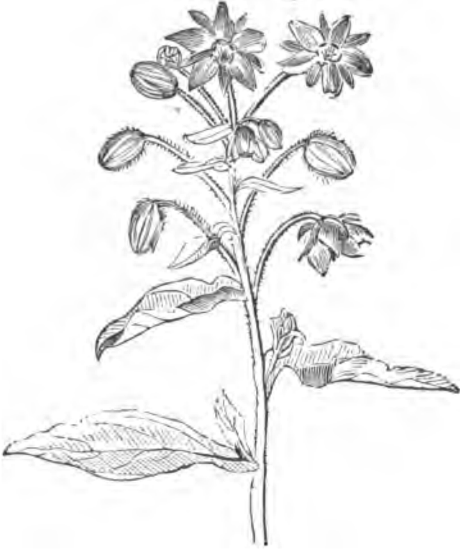
A SOLITARY AXILLARY flower is one where the peduncle starts from the axil of a leaf.

In Fig. 154 the peduncle of the lowest flower starts from the axil of the leaf, it is hence an axillary flower; but the peduncle of the lowest flower in Fig. 153 starts at the first node of the branch, the growth of which it terminates; it is hence a terminal flower.

EXERCISE XXXII.

Clustered Axillary and Terminal Inflorescence.

FIG. 156.

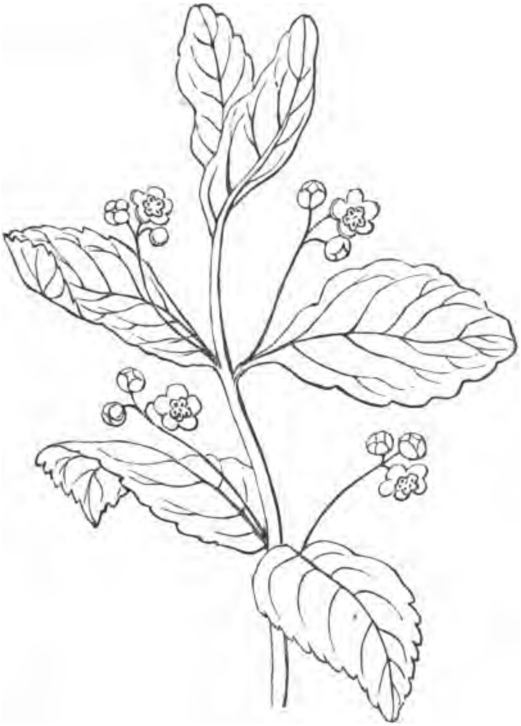


Clustered Terminal.

A TERMINAL CLUSTER of flowers is one that ends the growth of a stem, or branch. Fig. 156.

Observe that the lowest bud in Fig. 156 is hardly discernible as a flower-bud. The next is a little more advanced, the third still more, and so on till, at the top of the cluster, you see a fully expanded flower. The oldest flowers are at the top or centre of the cluster. This order is often reversed, the oldest flowers being at the bottom or outside of the cluster, and it is important for you to notice this circumstance in studying inflorescence.

FIG. 157.

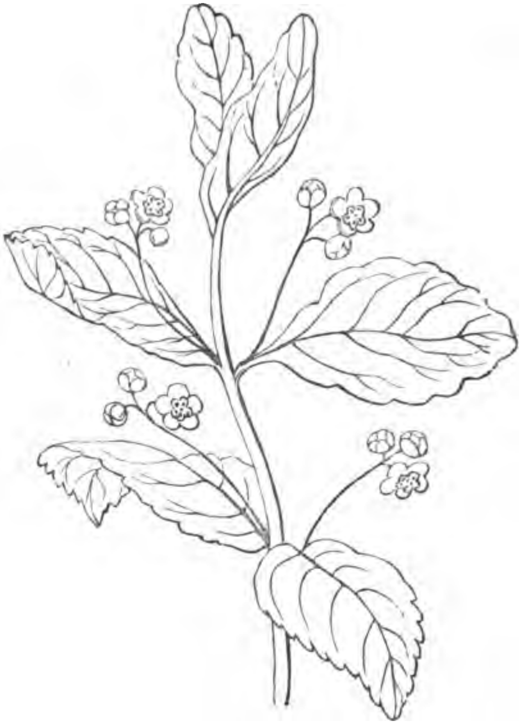


Clustered Axillary.

AN AXILLARY CLUSTER of flowers is one where the peduncle starts from a leaf axil.

The question, Position ? is now added to the inflorescence-schedule. Every inflorescence is either terminal or axillary, and the pupil is to determine this point, in order to answer the new question. When he begins the study of botany in its higher aspects, he will find that much depends upon his having carefully observed such points as these.

Fig. 159.

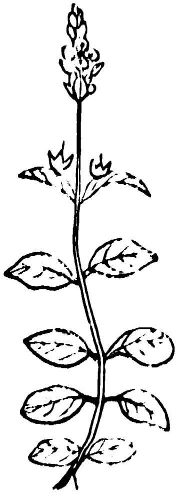


Indefinite.

All *axillary* inflorescence is Indefinite, because the stem and branches, if there be any, may grow on just the same as before blossoming. The inflorescence in Fig. 159 is indefinite. The stem does not end with flowers, but with a leaf-bud, which continues its growth.

The question, Kind? is now added to the inflorescence-schedule, and pupils will state, in answer, whether the inflorescence is definite or indefinite.

FIG. 160.



SCHEDULE TWENTY, DESCRIBING FIG. 160.

Parts?	Peduncle, Flowers, Rachis.
Attitude?	Erect.
Position?	Axillary.
Kind?	Indefinite.

LEAF.—Cauline, opposite, simple, sessile, feather-veined, entire, oval.

STEM round, erect, slender, herbaceous.

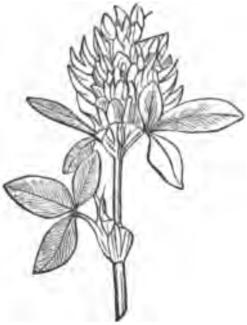
NOTE.—Compare Fig. 160 with Fig. 156, and observe that they differ in the order in which the flowers unfold. In Fig. 160 the oldest flowers are the lowest in the cluster. There is no flower at the top of the cluster, ending the growth of the

EXERCISE XXXIV.

Varieties of Inflorescence.

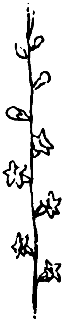
SIMPLE.

FIG. 161.



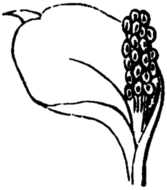
Head.

FIG. 162.



Spike.

FIG. 163.



Spadix.

HEAD.—A more or less globular cluster of flowers, sessile upon the receptacle.

SPIKE.—A cluster of flowers, sessile upon a rachis.

SPA'DIX.—A spike with a thick rachis, and covered around by a single large leaf, or bract, called a spathe.

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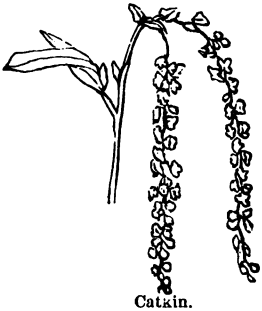
stem, and so, as the rachis may grow on, sending off flowers from its side, we say the inflorescence is indefinite.

The primary, or main stem, of a plant sometimes ends definitely, or with a flower, while the branches, or secondary stems, grow on, or are indefinite. Sometimes the main stem is indefinite, and the branches are definite. When both kinds of inflorescence are found upon the same plant, it should be stated.

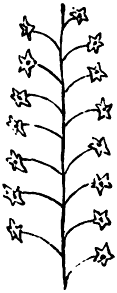
To determine whether a flower-head is definite or indefinite, observe whether the unopened flowers are at the top or on the lower part of the cluster. It is only in rare instances that they all open so nearly at the same time as to show no differ-

FIG. 164.



Catkin.

FIG. 165.

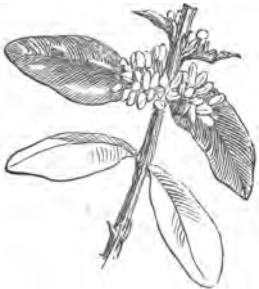


Raceme.

AMENT, OR CATKIN.—A *spike*, with sessile bracts among its flowers. It grows on trees and shrubs, and falls off after a while.

The RACEME is a flower cluster, where the flowers grow upon pedicels of about equal length along the rachis.

FIG. 166.



Glomerule.

A GLOMERULE is formed by nearly sessile clusters of flowers in the axils of opposite leaves.

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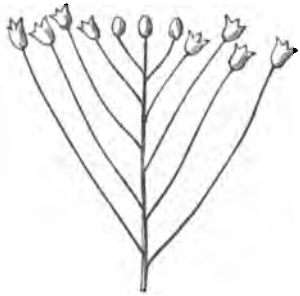
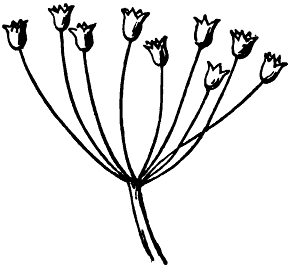
ence of age; but, when this is the case, you must leave the question undecided till you have discovered some other mode of solving it.

Fig. 167.



Corymb.

Fig. 168.



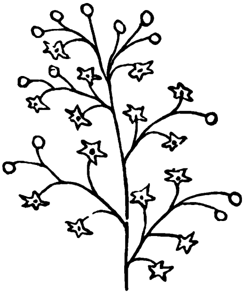
Umbel.

The **Corymb** is a flower cluster, with a short rachis, the lower pedicels of which are lengthened, so that the cluster is flat at top.

An **Umbel** has no rachis, and the pedicels are of nearly equal length.

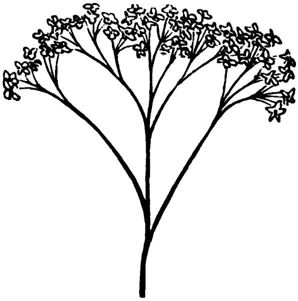
COMPOUND.

Fig. 169.



Compound Raceme.

Fig. 170.

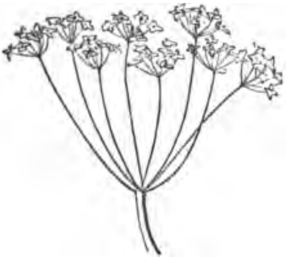


Compound Corymb.

A **Compound Raceme, or Panicle**, has a long rachis, and the flowers grow upon branches of the pedicels. When such a cluster is thick and cone-shaped, it is called a *Thryse.*

A **Compound Corymb** is a corymb with the flowers growing upon branches of the pedicels. Fig. 170.

Fig. 171.



Compound Umbel.

A **Compound Umbel** has a second umbel, or umbellet, upon each pedicel.

Note.—Most of the clusters pictured in this exercise are represented as without bracts, that differences in their modes of branching may be more easily compared. The pictures represent certain styles of flowering, and each of these styles varies very much in nature. You will find umbels very unlike each other, and very unlike Fig. 170, but still more nearly like that figure than any of the others. And so of panicles, corymbs, &c. Great differences among the clusters of one variety may be occasioned by the presence or absence of bracts, by their groupings, forms, and colors, by the length, stiffness, and ever varying positions of peduncles and pedicels, as well as by differences in the form of receptacles. And besides, the various sorts run together in many different ways. You will sometimes find a flower-cluster resembling two different varieties so much that you will have to combine the names of the two in order to characterize it properly; as, for instance, a corymbose panicle, a panicle of heads, or a spicose umbel. When you cannot name the variety, say so, and keep the instance in mind until it becomes clear to you.

Fig. 172.

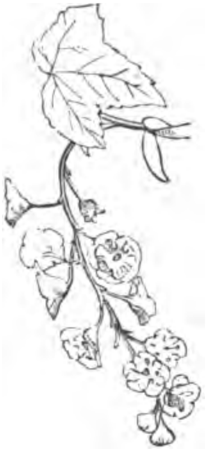


Fig. 173.

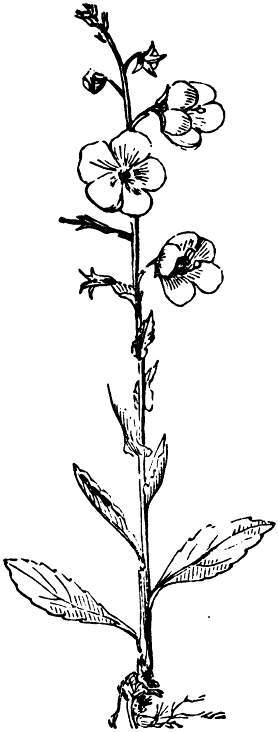
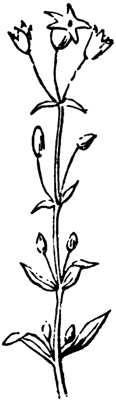


Fig. 174.



Note.—The difference between definite and indefinite flower-clusters is shown above. Fig. 172 represents an indefinite raceme, the growing end of which is surrounded by unopened flowers. In Fig. 174 the reverse is the case; the rachis *ends with a flower*—the oldest flower of the cluster, while at the other end, near the peduncle, the buds have scarcely begun to unfold. This, therefore, is clearly a definite raceme. In Fig. 173 the oldest flowers of the cluster are near the peduncle, the growing end is surrounded by undeveloped buds, and its kind is easily determined.

SCHEDULE TWENTY-ONE, DESCRIBING FIG. 173.

Parts?	Peduncle, Bracts, Rachis, Pedicels, Flowers.
Attitude?	Erect.
Position?	Terminal.
Kind?	Indefinite.
Variety?	Raceme.

LEAF.—Cauline, simple, sessile, exstipulate, feather-veined, serrate, oval-acute.

STEM.—Erect, round, herbaceous.

This is the last inflorescence schedule, and future descriptions of this part of plants will be made without the help of questions. There are some obvious characters of the inflorescence, easily understood and described, that have not been named in the schedule, and, that they may be noted in future descriptions, we call attention to them here.

When many flowers are crowded upon a rachis, or receptacle, the cluster is said to be *dense;* but when they are few and scattering, it is said to be *loose.*

The bracts of a cluster may be very numerous, or they may present peculiarities that a child can easily describe, such, for instance, as relate to shape or color, or they may form an involucre at the base of the cluster, and these points might well be included in a description.

CHAPTER IV.

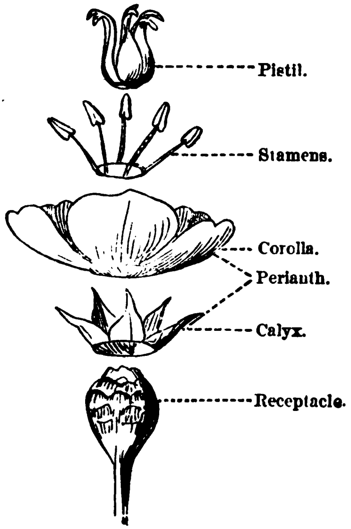
THE FLOWER.

EXERCISE XXXV.

Parts of the Flower.

FIG. 175 represents one flower—the parts, though separated, stand in their natural relation to each other.

FIG. 175.



RECEP′TACLE.—The top of the peduncle, more or less swollen, from which the flower grows.

CA′LYX.—The outer circle of green flower-leaves.

COROL′LA.—The inner circle of delicately-colored flower-leaves.

Per′ianth.—A name given to both circles of flower-leaves when they are so nearly alike as not to be separable into calyx and corolla.

Sta′mens.—Slender, thread-like parts next inside the corolla.

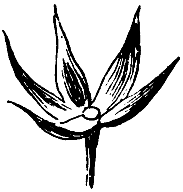
Pis′til.—The central part of the flower inside the stamens.

When there is but one whorl of flower-leaves, whatever its color, it is called a calyx.

EXERCISE XXXVI.

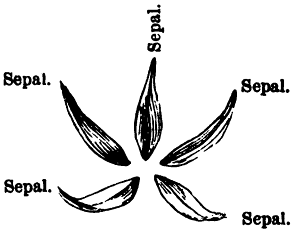
Parts of the Calyx.

Fig. 176.



Calyx.

Fig. 177.



Se′pal.—One of the leaves of the calyx.

Note.—The first thing in studying the flower is to become acquainted with its leading parts and their names. This is done by comparing numerous specimens with Fig. 175. The pupil is then ready to begin work with the flower schedule. Figs. 177 and 179 are given to assist the pupil in answering the first questions upon it. Write under the question, calyx? the names of the parts that compose the calyx, and under the question, corolla? the names of the parts that compose the corolla. Then count the sepals in your flower, and write their number after the word sepals, in the next column; count also the petals in the corolla, and write their number after the word petals.

EXERCISE XXXVII.

Parts of the Corolla.

FIG. 178.

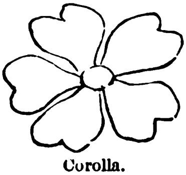
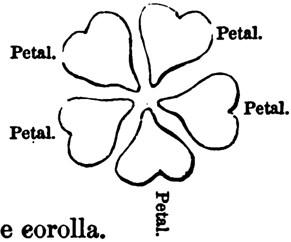


FIG. 179.



PET'AL.—A leaf of the corolla.

FIG. 180.

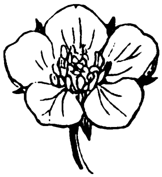
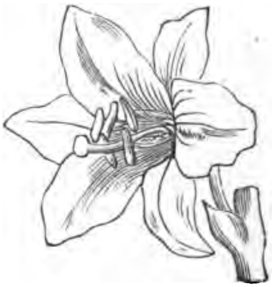


FIG. 181.



SCHEDULE TWENTY-TWO,
DESCRIBING FIG. 178.

Names of Parts.	No.	
Calyx ? *Sepals.*	 *5.*	
Corolla ? *Petals.*	 *5.*	

SCHEDULE TWENTY-THREE,
DESCRIBING FIG. 179.

Names of Parts.	No.	
Perianth ? *Leaves.*	 *6.*	

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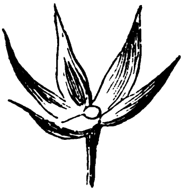
EXERCISE XXXVIII.

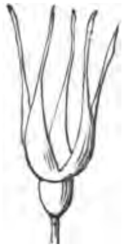
Kinds of Calyx.

Fig. 182.



Polysepalous Calyx.

Fig. 183.



Gamosepalous Calyx.

A Polysep′alous Calyx has its sepals distinct from each other, so that each one can be pulled off separately.

A Gamosep′alous Calyx has its sepals more or less grown together by their edges, so that, if you pull one, the whole calyx comes off.

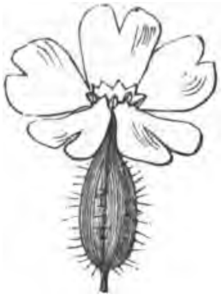
Having used schedules twenty-two and twenty-three till the names of the parts that compose the calyx, corolla, and perianth, are firmly associated with the parts themselves, we are now ready to begin their description. Schedule twenty-four shows you where to write what you have to say about them. Observe first whether the sepals of a calyx, the petals of a corolla, or the leaves of a perianth, are grown together or not. Sometimes they cohere so slightly, that close observation is necessary to ascertain it. Be cautious about pronouncing a corolla polypetalous until you have made many observations upon different specimens of it. Do not guess.

You can count the petals of gamopetalous corollas by their marks of cohesion.

EXERCISE XXXIX.

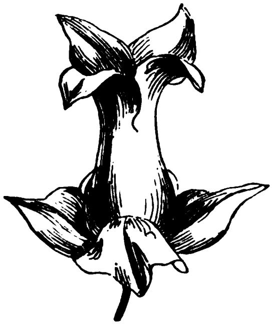
Kinds of Corolla and Perianth.

Fig. 184.



Polypetalous Corolla.

Fig. 185.



Gamopetalous Corolla.

A Polypet'alous Corolla has its petals distinct and separate from each other, so that each one can be pulled off without disturbing the others.

A Gamopet'alous Corolla has its petals more or less grown together by their edges, so that if you pull one the whole corolla comes off.

Schedule Twenty-four, describing Fig. 185.

Names of Parts.	No.	Description.
Calyx?		Gamosepalous.
Sepals.	4.	
Corolla?		Gamopetalous.
Petals.	4.	

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A Polyphyl′lous Perianth has its leaves entirely distinct and separate from each other.

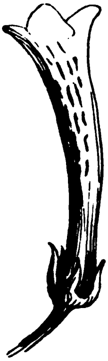
A Gamophyl′lous Perianth has its leaves more or less coherent by their edges.

In the schedule will be seen a space where the forms of sepals and petals should be recorded in the same terms used to describe leaves.

EXERCISE XL.

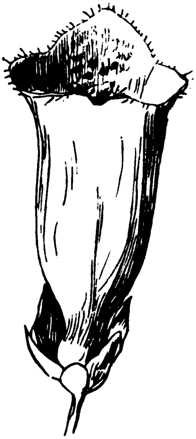
Regular and Irregular Corollas and Perianths.

Fig. 186.



Regular Gamopetalous Corolla.

Fig. 187.



Irregular Gamopetalous Corolla.

A Regular Calyx, Corolla, or Perianth, has its parts of the same size and shape.

An Irregular Calyx, Corolla, or Perianth, has its parts unlike in size or form.

Fig. 188.

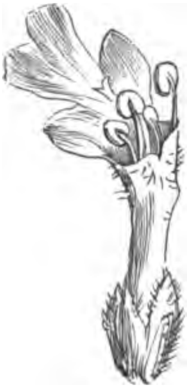
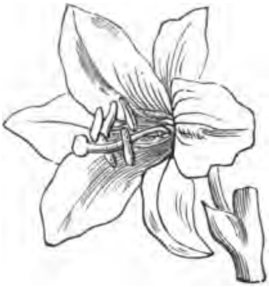


Fig. 189.



Schedule Twenty-five, describing Fig. 188.

Names of Parts.	No.	Description.
Calyx?		*Gamosepalous, irregular.*
Sepals.	*6.*	
Corolla?		*Gamopetalous, irregular.*
Petals.	*3.*	

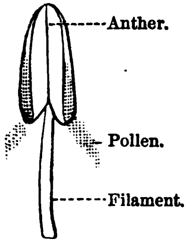
Schedule Twenty-six, describing Fig. 189.

Names of Parts.	No.	Description.
Perianth?		*Polyphyllous, regular.*
Leaves.	*6.*	

EXERCISE XLI.

Parts of Stamens.

FIG. 190.



FIL′AMENT.—The stem-like part of a stamen.

AN′THER.—The thickened oblong head of a filament.

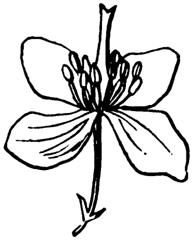
POL′LEN.—The dust, or powder, seen upon the anther.

Schedule twenty-seven has added to it the new question, Stamens? Write underneath it the name of the parts that compose a stamen of your flower. Count the number of stamens, and write it down, unless they are too numerous, when you will use the character ∞, signifying many. Write free, when they are so; and coherent, when they are grown together.

When the filament is absent, write sessile after anther. To describe the filaments, observe whether they are long or short, slender or thick, flat or round, distinct or grown together.

Observe whether the anthers are one-lobed or two-lobed, that is, whether they are in two parts or pieces; and note also whether they are oblong, round, curved, straight, large or small, longer or shorter than the filaments, distinct or grown together.

FIG. 191.



SCHEDULE TWENTY-SEVEN, DESCRIBING FIG. 191.

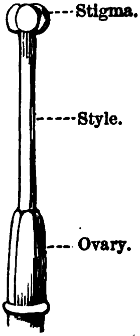
Names of Parts.	No.	Description.
Calyx?		Gamosepalous, regular.
Sepals.	2.	
Corolla?		Polypetalous, regular.
Petals.	4.	Obovate, Spreading.
Stamens?	∞	
Filament.		Slender.
Anther.		Two-celled, Oblong.

NOTE.—Our descriptions of pictured flowers are necessarily imperfect, because the pictures are themselves imperfect. As the pollen is not represented in Fig. 191, it is, of course, omitted from the schedule. We can say nothing, in a book, of the color or size of specimens; yet the plan of working is clearly illustrated, and pupils will not find it difficult, at this stage, to add such points without the guidance of a pattern schedule.

EXERCISE XLII.

Parts of the Pistil.

FIG. 192.



O'vary.—The lowest part of the pistil, containing the seeds.

Style.—The slender stem-like part of the pistil next above the ovary.

Stig'ma.—The top of the pistil.

EXERCISE XLIII.

Parts of the Ovary.

FIG. 193.

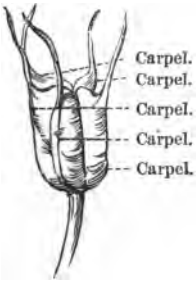
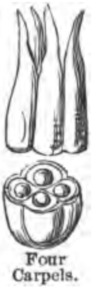


FIG. 194.



Car'pel.—One of the divisions, or cells, of the ovary.

FIG. 195.

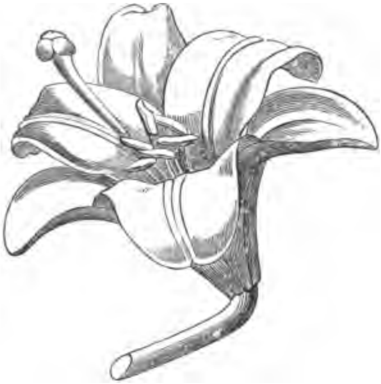


FIG. 196.

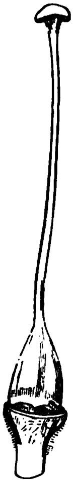
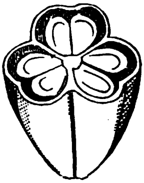


FIG. 197.



SCHEDULE TWENTY-EIGHT, DESCRIBING FIG. 195.

Names of Parts.	No.	Description.
Perianth ?		*Polyphyllous, regular.*
Leaves.	*6.*	
Stamens ?	*6.*	*Free.*
Filament.		*Slender.*
Anther.		*Oblong.*
Pistil ?		
Carpels.	*3.*	
Style.		*A single column.*
Stigma.		*Three-lobed.*

The question Pistil? is now added to the schedule, and is to be answered in the same way as the questions Perianth? and Stamens? First write the name of its parts underneath, and then find out, if you can, the number of carpels that compose the ovary. It is sometimes quite difficult to do this, but it is well always to make the effort. When the carpels cannot be distinguished, you determine their number by counting the styles, and, if these are grown smoothly together, then count the lobes of the stigma. It is very seldom that this part of the pistil is so coherent that the lines of union are invisible. You can often, in this way, find out the number of carpels in a pistil, when every other means fails. In describing the various forms of style no new terms are needed.

EXERCISE XLIV.

Parts of the Petals.

FIG. 198.

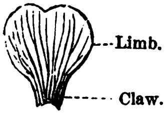
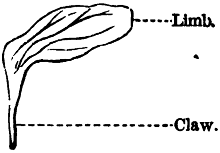


FIG. 199.



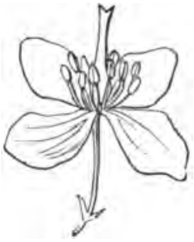
LIMB.—The upper, and usually the broadest and thinnest, part of a petal.

CLAW.—The lower part of a petal, which attaches it to the receptacle.

EXERCISE XLV.

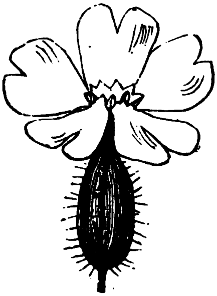
Kinds of Regular Polypetalous Corollas.

Fig. 200.



Cruciferous.

Fig. 201.

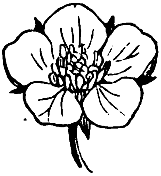


Caryophyllaceous.

A Crucif′erous Corolla has four petals growing in the shape of a cross.

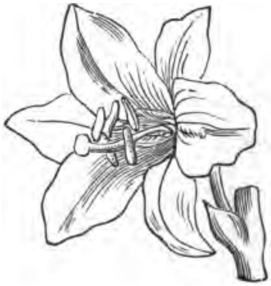
A Caryophylla′ceous Corolla has five petals, having each a long, slender claw, and a spreading blade.

Fig. 202.



Rosaceous.

Fig. 203.



Liliaceous.

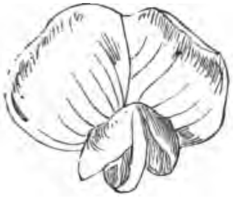
A Rosa′ceous Corolla has five petals, with spreading lamina and short claw.

A Lilia′ceous Perianth has six leaves, bending away something like a bell.

EXERCISE XLVI.

Kinds of Irregular Polypetalous Corolla.

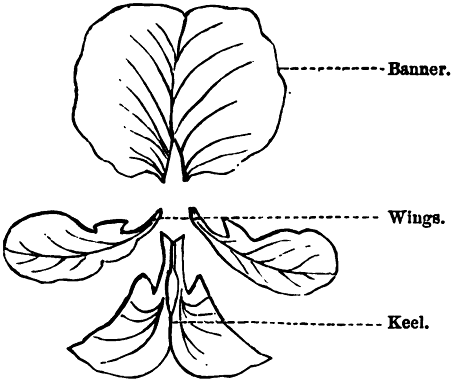
FIG. 204.



Papilionaceous Corolla.

FIG. 205.

FIG. 206.



The PAPILIONA′CEOUS COROLLA has five dissimilar petals, arranged like Fig. 204. The one nearest the stem (the upper, Fig. 206) is called the *banner;* the two side ones are called *wings*, and the lower one the *keel.*

NOTE.—Learn to distinguish the banner, wings, and keel of papilionaceous corollas, and note the differences of their forms in different kinds of flowers. You can write such observations upon the back of the schedule.

FIG. 207.

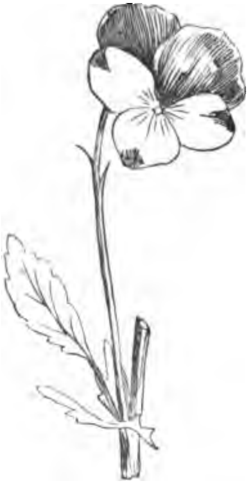


FIG. 208.

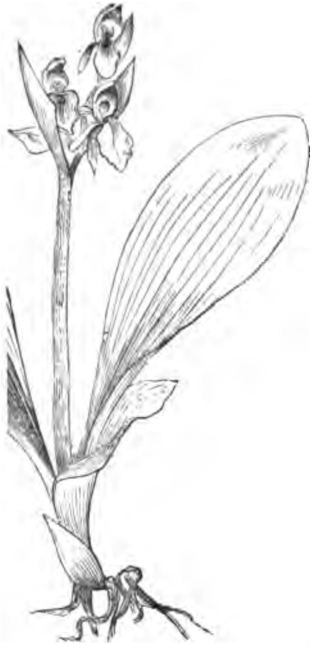
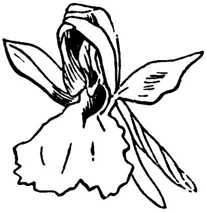


FIG. 209.



There are many other varieties of polypetalous irregular corollas which are described generally as *anomalous*. Fig. 207 is a common form of anomalous corolla. There is an interesting tribe of plants known as orchids, which present many anomalous forms of corolla; Fig. 208 is an example, Fig. 209 being a separate flower from the same plant. Anomalous flowers should be further described as polypetalous or gamopetalous, for they occur among both these forms.

FIG. 210.

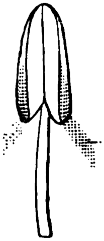


FIG. 211.

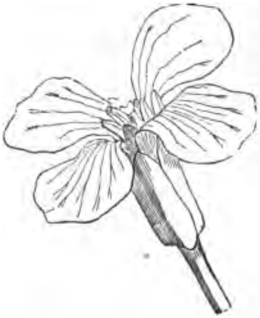
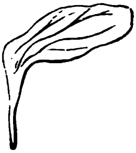


FIG. 212.



SCHEDULE TWENTY-NINE, DESCRIBING FIG. 211.

Names of Parts.	No.	Description.
Calyx?		*Polysepalous, regular.*
Sepals.	*4.*	*Oval.*
Corolla?		*Cruciform.*
Petals.	*4.*	*Claw, long, Limb, spreading.*
Stamens?	*6.*	
Anther.		*Oblong.*
Filament.		*Short as anther.*
Pollen.		
Pistil?		

EXERCISE XLVII.

Parts of a Gamopetalous Corolla.

Fig. 213.

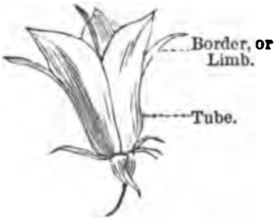
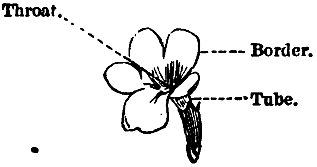


Fig. 214.



Tube.—That part of the corolla, whether long or short, in which the petals are united together.

Limb, or Border.—The upper part of the corolla, where the petals are not united.

Throat.—The opening of the tube.

Corolla Tubes may be long or short, slender or swollen, tapering or cylindrical, or with a pouch, or sack, on one side.

The Limb may be narrow or broad, erect or spreading; and,

The Throat is either open or constricted, hairy or smooth.

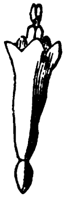
Note these features in describing gamopetalous corollas.

Note.—The last exercises of this chapter introduce twenty or thirty new terms, expressive of as many different ideas of form. In learning the precise word for each form, proceed very slowly from exercise to exercise, searching constantly for illustrative specimens. Learn the names of the parts of a petal and of a gamopetalous corolla. Let time be taken to examine all the flowers that can be found, comparing their corollas with the pictures, fixing, for each flower, upon the picture it most nearly resembles.

EXERCISE XLVIII.

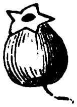
Kinds of Regular Gamopetalous Corollas.

FIG. 215.



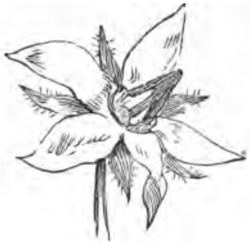
Tubular.

FIG. 216.



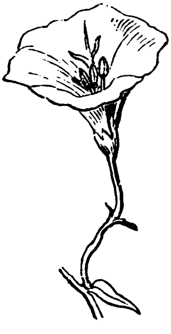
Urceolate.

FIG. 217.



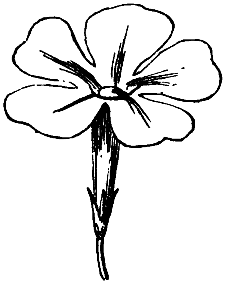
Rotate.

FIG. 218.



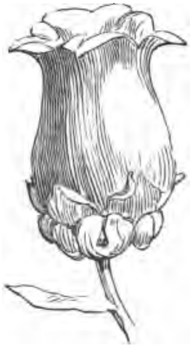
Funnel-form.

FIG. 219.



Salver-form.

FIG. 220.



Campanulate.

TU′BULAR.—A tubular corolla is one in which the tube spreads little or none at the border. Fig. 215.

UR′CEOLATE.—A corolla is urceolate when the tube is swollen in the middle, with a narrow opening like an urn, as in Fig. 216.

RO′TATE, OR WHEEL-SHAPED COROLLAS have a short tube and flat, spreading border. Fig. 217.

Fun'nel-form.—When the corolla-tube is small below, and enlarges gradually to the border, as in Fig. 218.

Sal'ver-form.—When the long, slender tube of a corolla ends abruptly in a flat spreading border, as seen in Fig. 219.

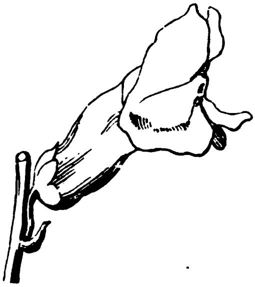
Campan'ulate.—Bell-shaped corollas are said to be campanulate. Fig. 220.

EXERCISE XLIX.

Irregular Gamopetalous Corollas.

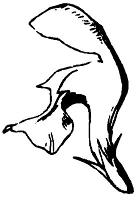
Labiate Corollas.

Fig. 221.



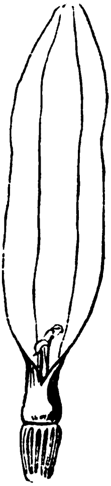
Personate.

Fig. 222.



Ringent.

Fig. 223.



Ligulate.

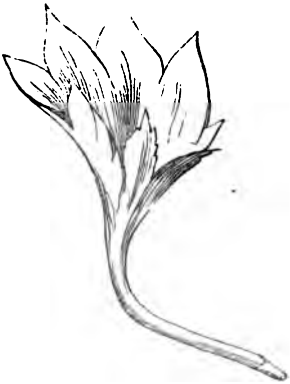
La'biate.—In labiate corollas the limb has the appearance of lips; Figs. 221 and 222. Labiate corollas are of two kinds, personate and ringent.

Per'sonate.—With the throat closed. Fig. 221.

Rin'gent.—With the throat open. Fig. 222.

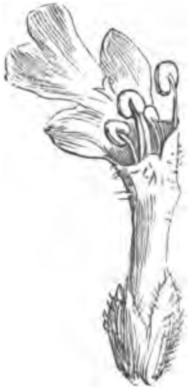
A Lig'ulate, or strap-shaped, corolla, is one which appears as if it were formed by the splitting of the tube on one side. Fig. 223.

Fig. 224.



Anomalous.

Fig. 225.

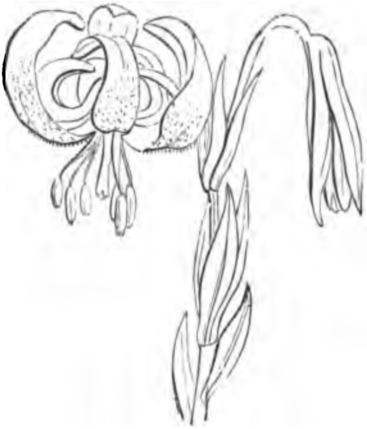


Anomalous.

Anom'alous.—All other irregular gamopetalous corollas, as Figs. 224 and 225, are called *anomalous*.

In describing corollas, the terms cruciferous, liliaceous, tubular, etc., may now be used in place of polypetalous, gamopetalous, regular and irregular, as the new terms include these characters, along with others, more limited and special. To say, for example, that a corolla is *cruciferous*, is to say that it is polypetalous and regular, and also to state the number and position of its petals. To say that a corolla is *strap-shaped*, is the same as saying that it is gamopetalous and irregular as well as what particular form it has.

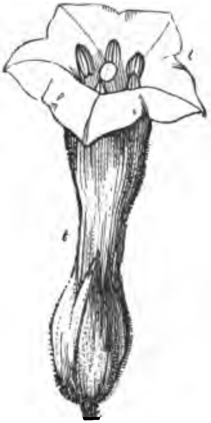
FIG. 226.



SCHEDULE THIRTY, DESCRIBING FIG. 226.

Names of Parts.	No.	Description.
Perianth ?		*Liliaceous.*
Leaves.	*6.*	*Lanceolate, Recurved.*
Stamens ?	*6.*	
Filament.		*Long, Slender.*
Anther.		*Two-celled, Oblong.*
Pistil ?		
Carpels.	*3.*	
Style.		*Single, Smooth.*
Stigma.		*Three-cleft.*

Fig. 227.



SCHEDULE THIRTY-ONE, DESCRIBING FIG. 227.

Names of Parts.	No.	Description.
Calyx?		Gamosepalous.
Sepals.	5.	
Corolla?		Salver-form.
Petals.	5.	
Stamens?	5.	
Filament.		
Anther.		
Pistil?		
Carpels.		
Style.		
Stigma.		

EXERCISE L.

Crowns, Spurs, and Nectaries.

FIG. 228.

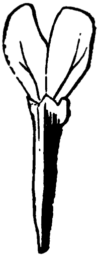
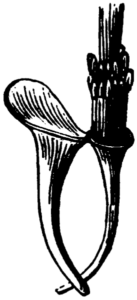


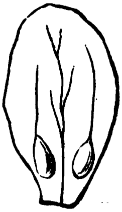
FIG. 229.



The CORONA, or CROWN, is a scale-like structure (Fig. 228) on the inner surface of corollas, at the summit of the claw, or tube.

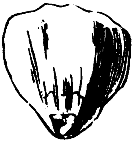
A SPUR is a tubular prolongation of a petal or sepal. Fig. 229.

FIG. 230.



Nectary.

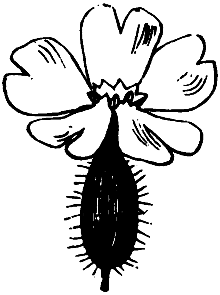
FIG. 231.



Nectary.

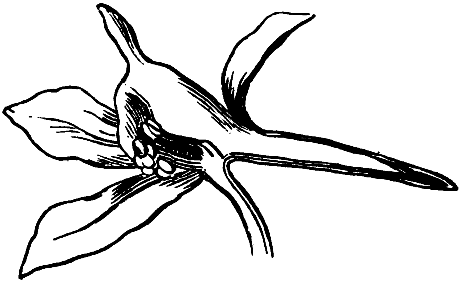
A NECTARY is a little gland on the claw of a petal that secretes a sugary liquid. In Fig. 230 these glands are naked, while in Fig. 231 the little gland is covered by a scale.

FIG. 232.



Corolla with Crown.

FIG. 233.



Spurred Calyx and Corolla.

The statement proper in describing the corolla (Fig. 232) is as follows:

Corolla ?		*Caryophyllaceous.*
Sepals.	*5.*	*Limb, obcordate; crown at base.*

We describe a calyx and corolla like that shown (Fig. 233) as follows:

Calyx ?		
Sepals.	*5.*	*Upper one spurred.*
Corolla ?		*Polypetalous, anomalous.*
Petals.	*4.*	*Upper one with spur, prolonged into calyx spur.*

CHAPTER V.

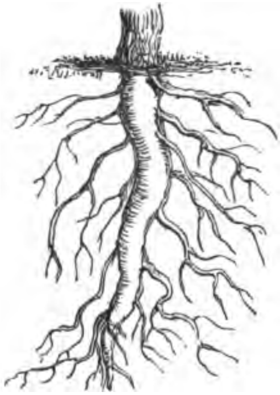
THE ROOT.

EXERCISE LI.

Tap-Roots and Fibrous Roots.

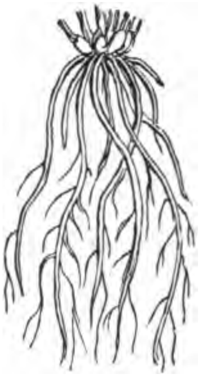
THERE are two classes of roots, called tap-roots and fibrous roots, which differ from each other in the way shown in Figs. 234 and 235.

FIG. 234.



Tap-root.

FIG. 235.



Fibrous Root.

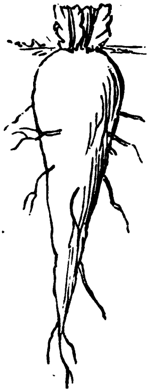
Fig. 234 represents a TAP-ROOT, which is seen to be simply a continuation of the stem downward.

In Fig. 235 the stem is not continued downward as a tap-root, but sends off rootlets or fibres at the outset. It is hence called a FI'BROUS ROOT.

EXERCISE LII.

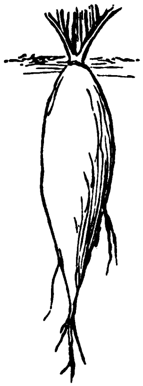
Kinds of Tap-Root.

Fig. 236.



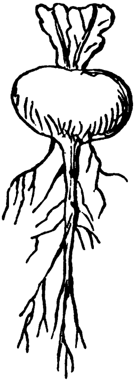
Conical Root.

Fig. 237.



Fusiform Root.

Fig. 238.



Napiform Root.

Con′ical Roots are tap-roots, which taper gradually downward, and so are shaped like a cone. Fig. 236.

Fu′siform, or Spindle-shaped Roots, are tap-roots enlarged in the middle of their length, and tapering toward both ends. Fig. 237.

A Nap′iform, or Turnip-shaped Root (Fig. 238), is a tap-root, more or less globular in form.

The kinds of tap-root illustrated in this exercise are equally continuations of the stem, with that shown in Fig. 234. By reference to Fig. 116, it will be seen that these stems are made up of nodes, and are just as really stems as those in which the intervals between the nodes are considerable.

EXERCISE LIII.

Kinds of Fibrous Roots.

FIG. 239.

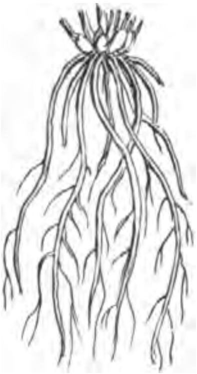
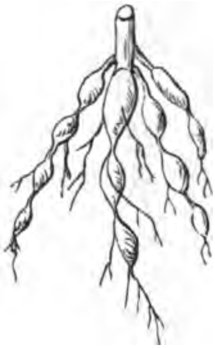
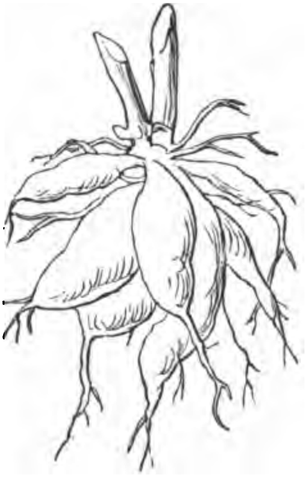


FIG. 240.



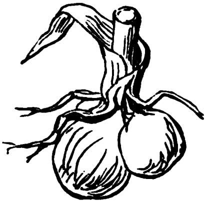
Moniliform Root.

FIG. 241.



Fasciculated Root.

FIG. 242.



Tubercular Root.

In MONIL'IFORM ROOTS (Fig. 240) some of the fibres have numerous small swellings, that succeed each other so as to look like a string of beads.

In FASCIC'ULATED ROOTS (Fig. 241) the fibres become swollen along their length, and look like a bundle of fusiform roots.

When some of the rootlets of fibrous roots become fleshy and enlarged, taking the form shown in Fig. 242, they are called TUBERCULAR ROOTS.

NOTE.—It is not difficult to see that the moniliform root is only a fibrous root, in which regular portions of the fibres have become swollen. When all these swellings unite in one continuous enlargement, we have a fasciculated root (Fig. 241). When the swellings are shortened and globular (Fig. 242), we name them tubercular roots, but their resemblance to the fibrous root is still apparent.

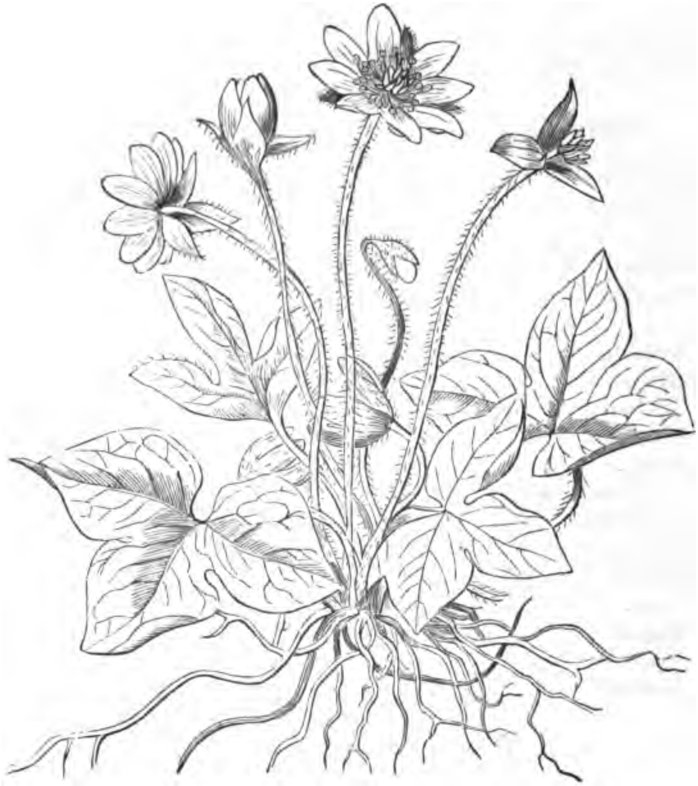
The questions about roots suggested by this chapter are, first, is the specimen in hand a tap or fibrous root? The answer may not always be easy, but the pupil will exercise his best judgment upon it. If it be fibrous, however, say so; if any modification of fibrous, say which, and similarly if the kind be a tap-root. For aid in describing roots, we must refer pupils to the exercises in plant description, which follow.

There is usually a certain balance between the size of the root and stem of a plant; but sometimes the root is very small compared with the stem and branches, and sometimes it is large. Roots may also be loosely attached to the soil or firmly planted therein; they may be spreading near the surface, or may grow directly downward, and such facts are worthy of note in root descriptions.

EXAMPLES IN PLANT DESCRIPTION,

ILLUSTRATIVE OF THE FOREGOING EXERCISES.

Fig. 242.



Description of Fig. 242.

ROOTS fibrous.

LEAVES radical, petiolate, exstipulate, palmate-veined, acutely three-lobed; base cordate, surface hairy. *Bracts* hairy, in a whorl of three near the flower.

INFLORESCENCE solitary, on a slender hairy scape.*

FLOWER. CALYX; *sepals* 8–12, oblong spreading: COROLLA none: STAMENS many; *filaments* threadlike; *anthers* oval, two-celled: PISTIL; *carpels* many; *style* very short; *stigma* continued down the inner face of the style.

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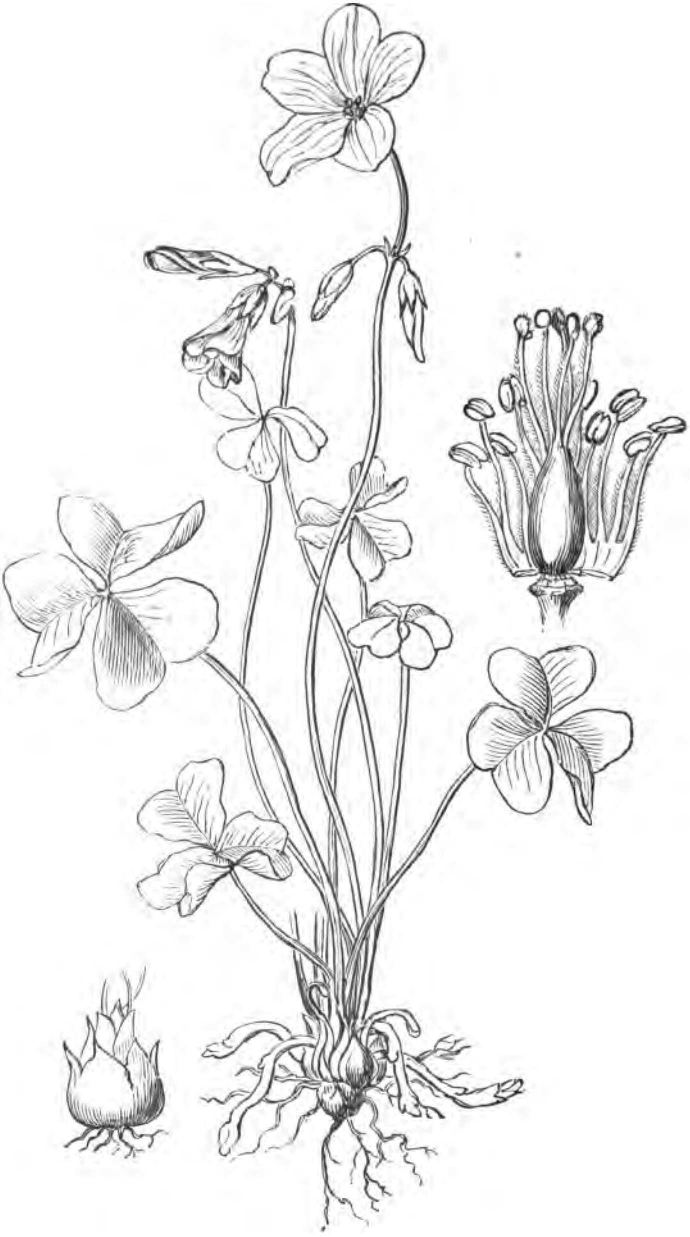
* Scape, a peduncle which arises from an underground stem.

Fig. 243.



Description of Fig. 243.

ROOTS fibrous.

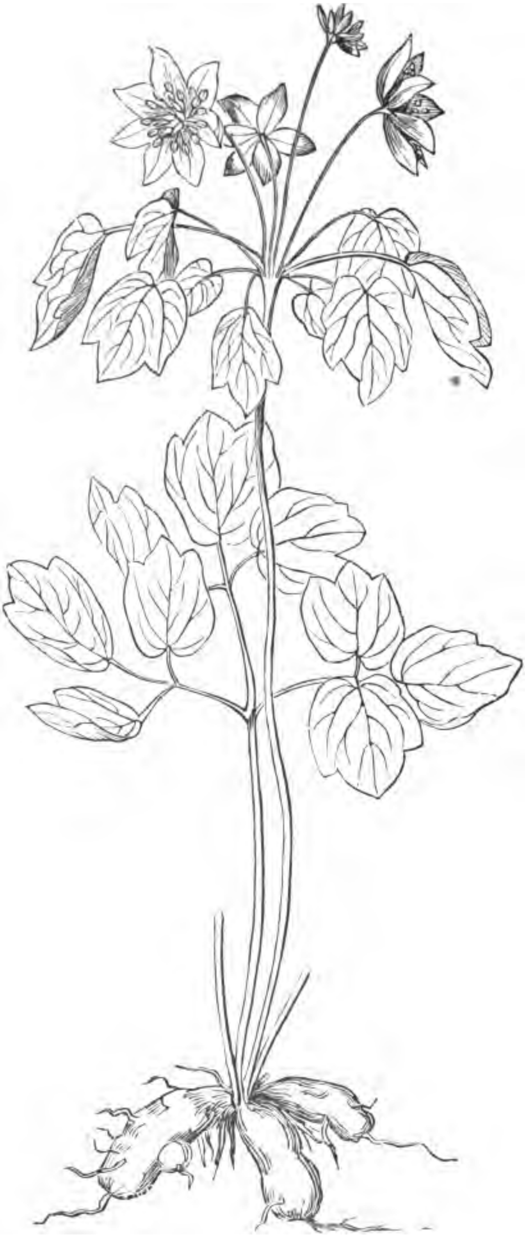
STEM a scaly bulb.

LEAVES radical, petiolate, exstipulate, digitately three-fingered; *leaflets* sessile, feather-veined, entire, obcordate; *petiole* long, slender.

INFLORESCENCE a loose terminal umbel.

FLOWER. CALYX; *sepals* 5, polysepalous: COROLLA; *petals* 5, regular, polypetalous, obovate, much larger than the sepals: STAMENS 10, of unequal length, hairy; *filaments* awl-shaped, flattened below, grown together; *anthers* short, oval, two-celled: PISTIL: *ovary* ovoid, of 5 united *carpels; styles* free, hairy; *stigmas* enlarged, rounded.

FIG. 244.



Description of Fig. 244.

ROOTS fasciculated.

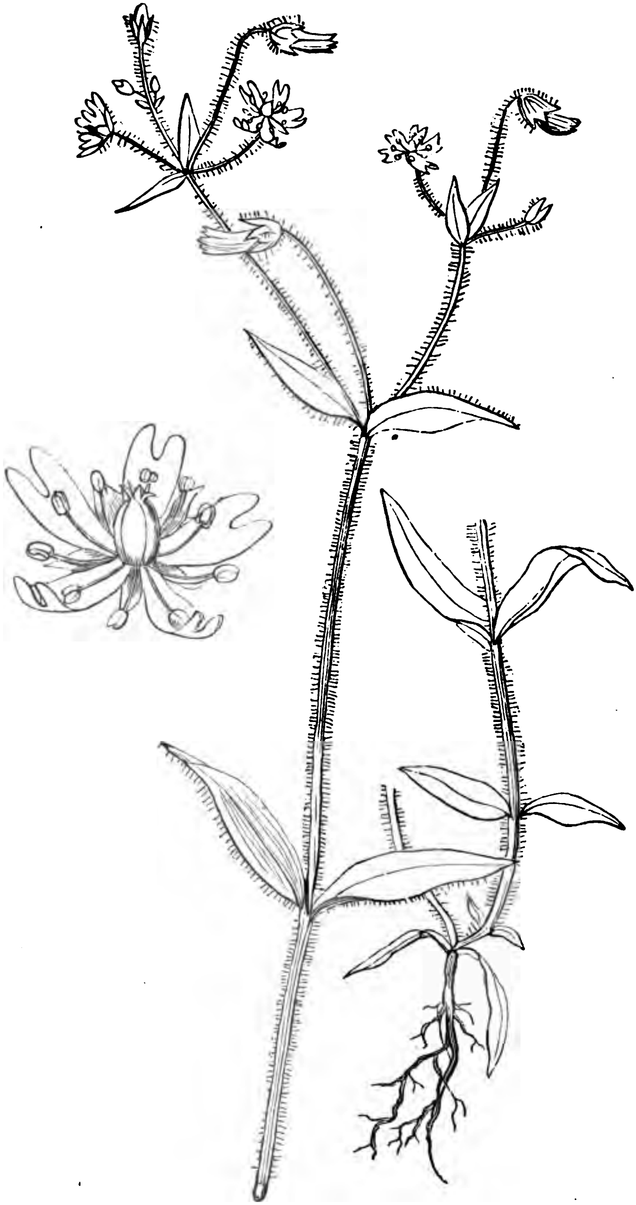
STEM erect, round, slender, herbaceous.

LEAVES radical and cauline. Radical leaves twice ternately three-fingered; *leaflets* petiolulate, palmate-veined, three-lobed at the end, sub-cordate; *petiole* long and slender. Cauline leaves numerous, simple, petiolate, exstipulate, formed like the leaflets of the radical leaves, placed in a whorl at the base of the inflorescence.

INFLORESCENCE a loose terminal umbel.

FLOWER. CALYX; *sepals* 6–8, spreading, polysepalous, regular: COROLLA; *petals* none: STAMENS many; *filaments* thread-like; *anthers* two-celled: PISTIL; *carpels* many.

Fig. 245.



Description of Fig. 245.

ROOTS branching tap.

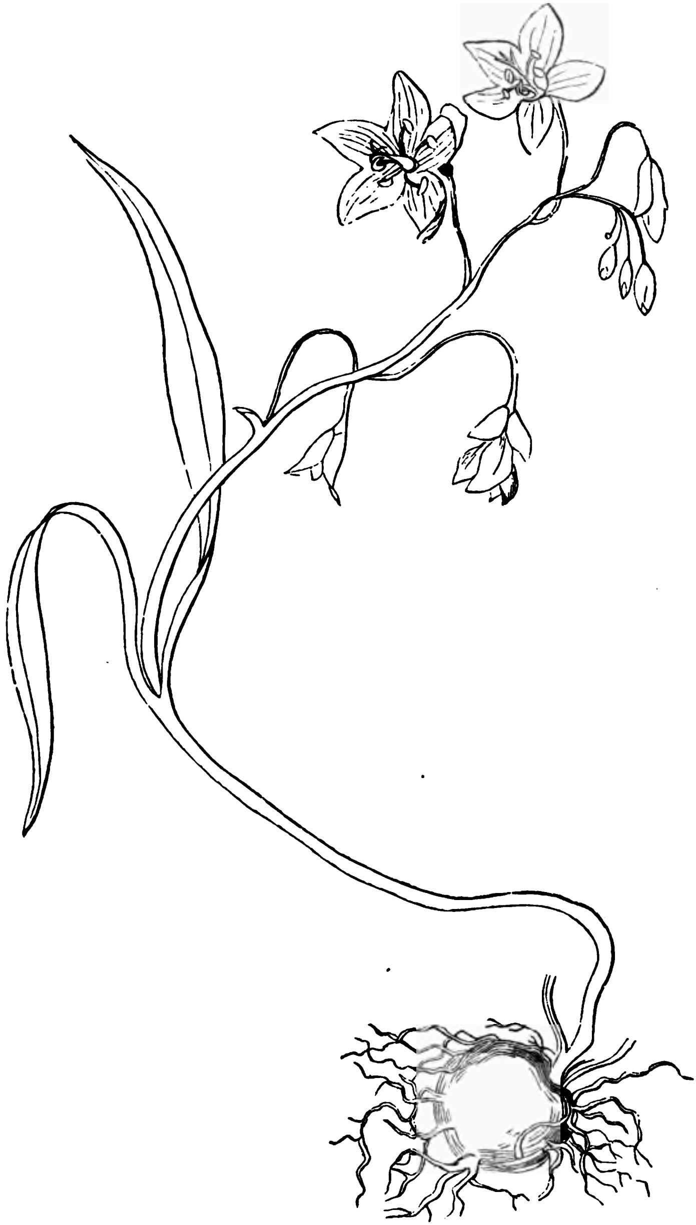
STEM erect, slender, herbaceous, round, hairy.

LEAVES cauline, opposite, simple, sessile, exstipulate, entire, ovate-acute.

INFLORESCENCE clustered, terminal, umbellate.

FLOWER. CALYX; *sepals* 5: COROLLA; *petals* 5, obcordate, spreading: STAMENS 10; *filaments* thread-like; *anthers* oval, two-celled: PISTIL; *ovary* ovoid, consisting of five united carpels; *styles* short, free; *stigma* along the inner face of the style.

Fig 246.



Description of Fig. 246.

Roots tuberous.

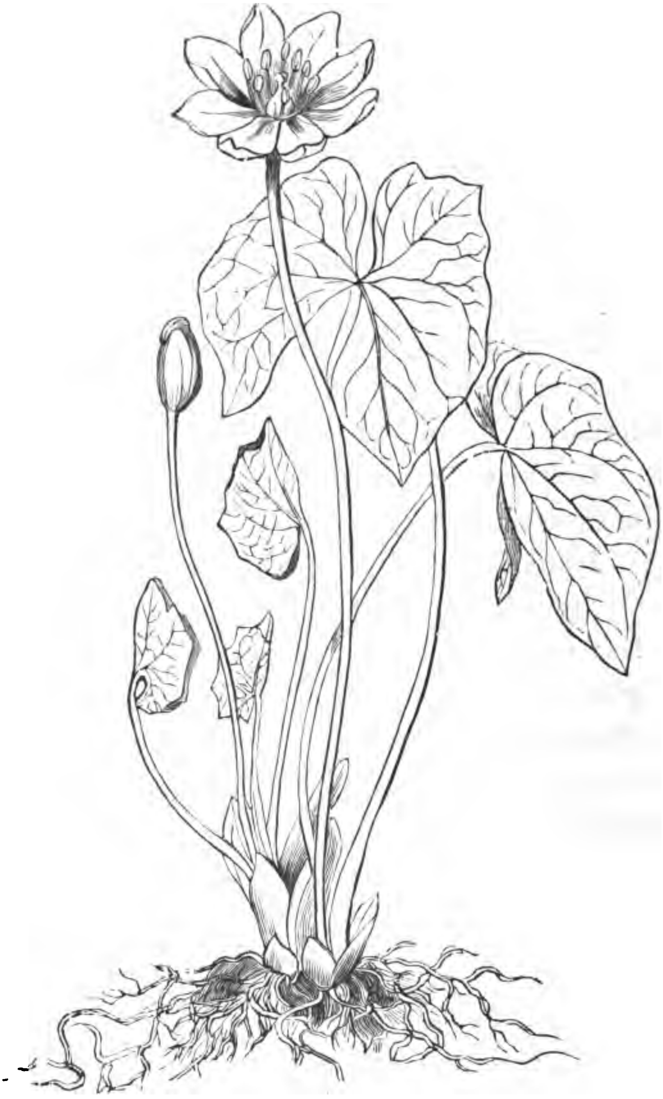
Stem smooth, low, weak, slender, herbaceous, round.

Leaves cauline, opposite, a single pair, sessile, exstipulate, feather-veined, entire, lanceolate.

Inflorescence a loose definite raceme.

Flower. **Calyx** ; *sepals* 2, polysepalous, regular : **corolla** ; *petals* 5, polypetalous (or slightly coherent at the short claws), spreading ; *stamens* 5 ; *filaments* threadlike ; *anthers* oval : **pistil** ; carpels 3 ; *style* slender, three-cleft ; *stigma* along the inner side of the three-cleft style.

Fig. 247.



Description of Fig. 247.

ROOTS fibrous, matted, somewhat spreading.

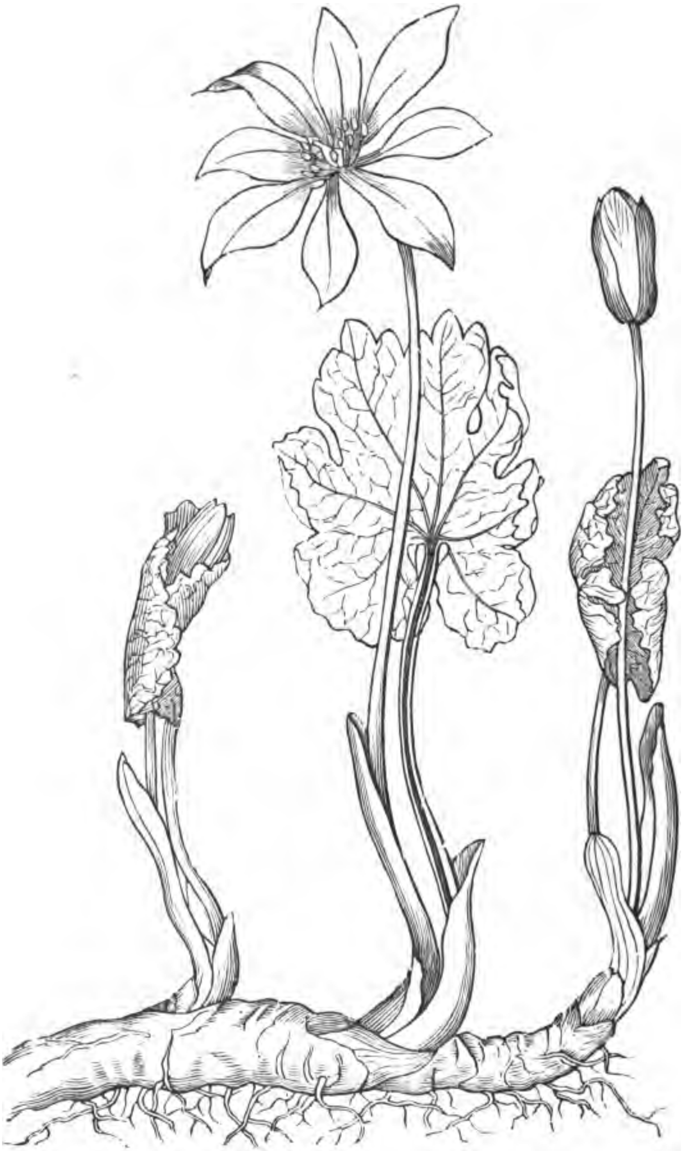
STEM of scaly nodes, internodes none.

LEAVES radical, simple, exstipulate, peltately palmate-veined, wavy, deeply two-lobed, shut sinus at base; *petiole* long, round, rather erect.

INFLORESCENCE solitary, on a smooth, naked scape.

FLOWER. CALYX; *sepals* 4, polysepalous, oblong: COROLLA; *petals* 8, polypetalous, regular, oblong, spreading: STAMENS 8; *filaments* threadlike, shorter than anther; *anthers* two-celled, oblong: PISTIL; carpels 2; *style* short; *stigma* spreading, two-lobed.

FIG. 248.



Description of Fig. 248.

Roots fibrous, growing from the entire under-side of the stem.

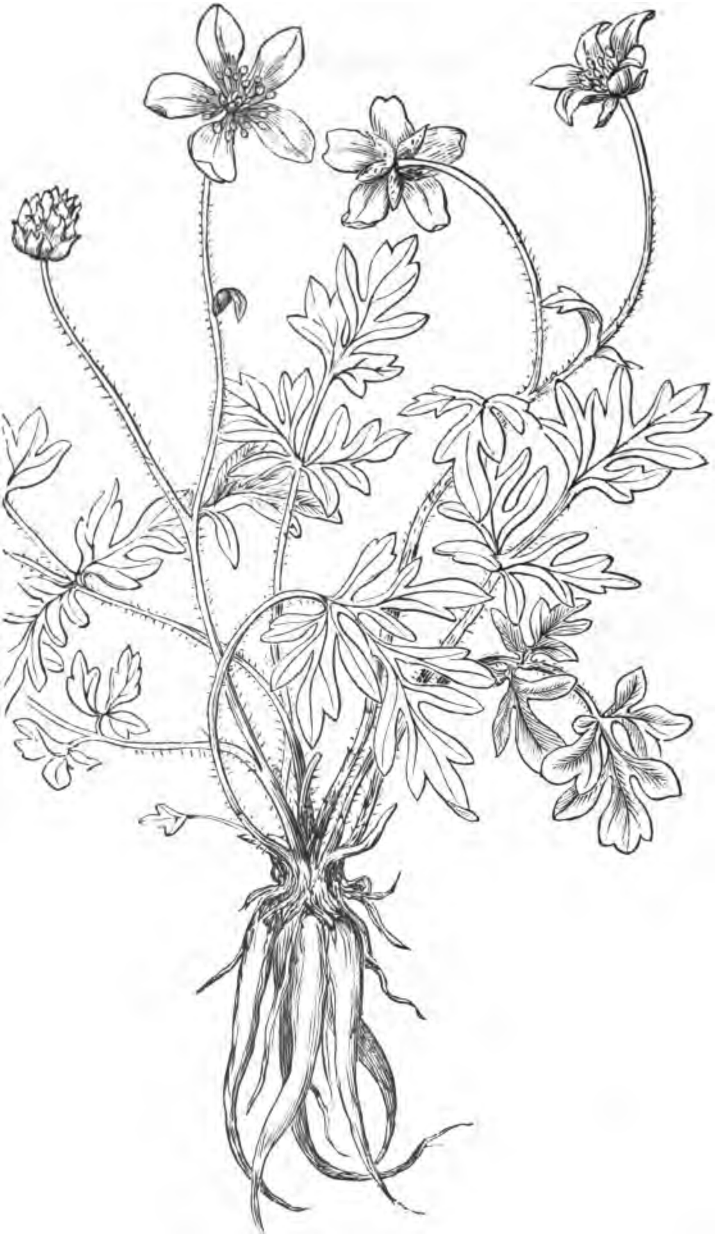
Stem creeping below the ground.

Leaf radical, petiolate, exstipulate, wavy-dentate, palmate-veined, slightly reniform, obtusely seven-lobed, sinuses rounded, nearly closed; *petiole* half-round, channelled.

Inflorescence solitary, on a smooth, slender scape.

Flower. Calyx; *sepals* 2, ovate, regular: corolla; *petals* 8, polypetalous, regular, obovate-oblong, spreading: stamens many, shorter than the petals; *filaments* short, threadlike; *anthers* oblong, two-celled: pistil; ovary oblong, of two carpels; *styles* united in a column; *stigma* two-lobed.

FIG. 249.



Description of Fig. 249.

ROOTS fasciculated.

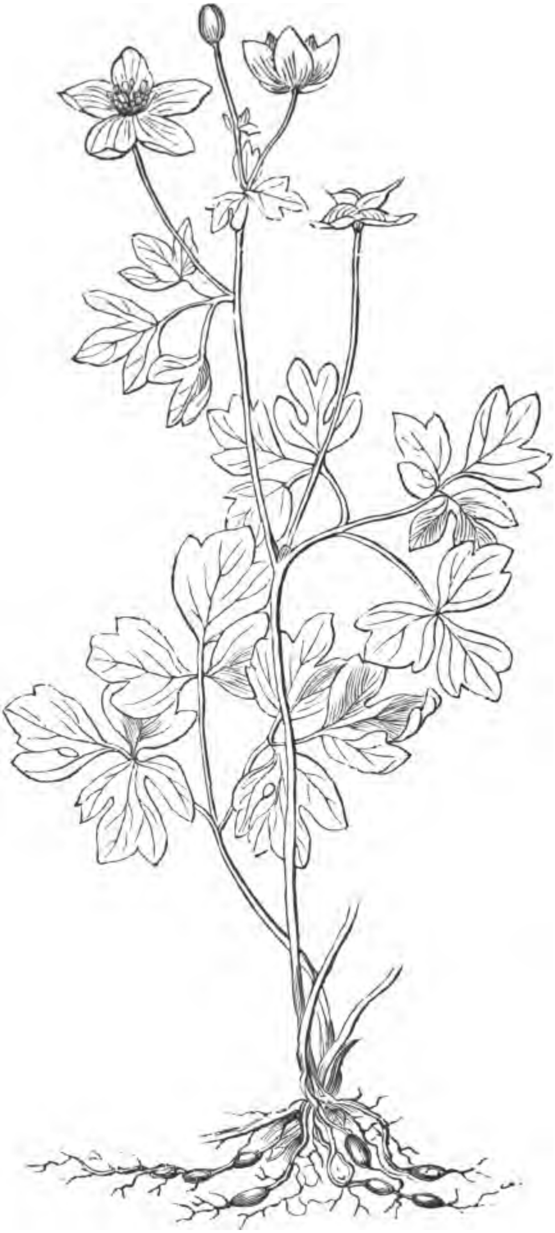
STEM slender, weak, round, herbaceous, hairy.

LEAVES radical and cauline. Radical leaves, petiolate, exstipulate, deeply twice ternately lobed; *petioles* long, hairy. Cauline leaves sessile alternate, shaped like the radical leaves, but much smaller.

INFLORESCENCE solitary, terminal.

FLOWER. CALYX; *sepals* 5, polysepalous, regular, spreading: COROLLA; *petals* 5, polypetalous, regular, oval, spreading: STAMENS many; *filaments* threadlike; *anthers* short, two-celled: PISTIL; *carpels* many; *styles* very short or absent; *stigma* inner and upper part of carpel or style.

FIG. 250.



Description of Fig. 250.

ROOTS moniliform.

STEM erect, slender, herbaceous, round.

LEAVES radical and cauline, ternately compound. Cauline leaves alternate; *leaflets* lobed; *petioles* spreading at base.

INFLORESCENCE solitary, terminal.

FLOWER. CALYX; *sepals* 5, polysepalous, regular, spreading, ovate: COROLLA; *petals*, none: STAMENS numerous; *filaments* threadlike; *anthers* oblong: PISTIL; *carpels* many; *stigma* sessile on the upper, inner face of carpel.

CHAPTER VI.

THE SEED.

EXERCISE LIV.

Parts of the Seed.

WE now pass to another class of observations, in which, besides noting new parts of plants, you will also have to watch the changes which take place in those parts.

PREPARE for the study of seeds by planting all the kinds you can get that are large enough for easy examination.

The seeds of the pumpkin, squash, four-o'clock, bean, pea, apple, Indian corn, oats, and barley, are good examples for the purpose. Plant two or three dozens of each sort, one inch deep, in a box of soil or sawdust, which must be kept warm and moist. Put the different kinds in rows by themselves, and mark each row, so that, when you want any particular one, you can get it without mistake.*

You should also be provided with a blank-book in which to write the results of study. Such a note-book is easily made by twice folding enough sheet-paper to allow a page to each kind of seed you have planted. Write the name of a kind, as pea, oat, etc., on each successive page, till all are inserted.

---

* If pupils cannot get time to prepare for these exercises out of school-hours, they should be encouraged to do it during school-time.

When your seeds have soaked for a day or two in the wet earth, take a bean from the box and compare it with one that has not been planted.

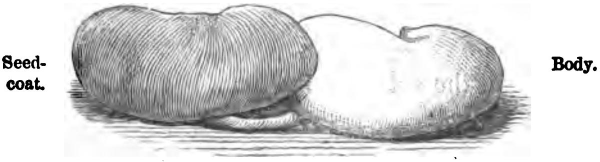
How has it changed in appearance?

Cut it in two and see whether, like a piece of chalk, it looks alike outside and inside, or whether the parts are unlike.

Has it a skin or shell that you can loosen?

Take a second bean from the box, cut carefully around it, and try to peel off the outer part.

FIG. 251.



SEED-COAT, OR INTEG′UMENT.—The skin or shell around the outside of a seed.

BODY, KERNEL, OR NU′CLEUS.—The substance within the seed-coat.

Compare your specimen with Fig. 251.

Can you separate the seed-coat from the body of the bean as it is seen to be separated in the picture?

Now take a pea from your box and see if it is made up of parts.

Has it a seed-coat? Is there a kernel or body within the seed-coat?

Try a pumpkin-seed. Compare the coat of a pumpkin-seed with that of the pea or bean.

Are they alike in thickness? in hardness? in color? in transparency? Name all the differences you see between them.

In the same way, take up and examine, one after another, some seeds from each of the rows. Find their parts, and compare the parts of one kind of seed with those of another kind.

If you are not able at first readily to separate a seed into distinct portions, do not hastily conclude that it is without them. Let it lie in its warm, wet bed a while longer, and then try again.*

Now write in your note-book just what you have discovered about the parts of seeds. For instance: if at the top of the first page you have written *bean*, on the line beneath you now write the question, Parts? and the answer which you have found to this question—thus:

Parts? Seed-coat. Body. Coat, thin, skinny; or, on the page devoted to the apple-seed, you write

---

* Much that is important in their experiments, children will fail to see, and they will fancy they see much that does not exist. Their omissions, misinterpretations, and difficulties, can be dealt with in many ways, but a desire on the part of the teacher for nicety of experiment, and accuracy of statement, should never lead to discouraging criticism. To keep the child happily busy with his growing plants is the main thing, and all degrees of awkwardness and imperfection in childish performance should be tolerated.

Parts? Seed-coat. Body. Coat, woody, brown, thin;

or, on the page for pumpkin-seed you say

Parts? Seed-coat. Body. Coat, shelly, thick, limber.

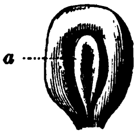
Write on all the pages of your note-book in this way, and keep it at hand for reference.

EXERCISE LV.

Parts of the Body, or Kernel.

When you have carefully examined all the seeds you planted to find the parts that make them up, you will be ready to study one of these by itself. After taking off the skin or coat of a seed, look closely at the body of it. Begin with a well-soaked seed of Indian corn.

Fig. 252.



Compare it with Fig. 252.

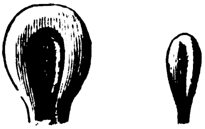
Is your seed narrower at one end than the other? Are the two sides of it alike? Is there a little pointed or rounded figure to be seen on one side?

Remove the skin and look carefully at the figured side of your specimen. Can you see a thick, lumpy body like the one marked *a* in the picture?

Try, with a dull knife or the finger-nail, to pry this lump out of its bed. If the seed is soaked to its centre, you can easily do this. Look carefully at the hole it leaves. Is not its surface smooth? Do you see any spot where the lump seems to have been grown to the other part, and to have broken away when you took it out?

Compare the parts you have got with Fig. 253.

FIG. 253.



EM′BRYO.—The young plant contained in a seed.

ALBU′MEN, EN′DOSPERM.—The material in which the embryo is embedded.

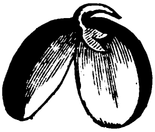
What names are given to the two parts of the body of a seed of Indian corn?

Which is the embryo in your specimen? Which is the albumen?

Now examine the kernel of a pea or bean. Can you separate this into two parts without breaking it somewhere?

Compare it with Fig. 254.

FIG. 254.



What name is given to the entire kernel? What part, found in the Indian corn, is missing here?

Look at the body of a seed of four-o'clock and see how many and what parts it has? Look also at the body of a pumpkin-seed.

Examine the kernel of each of the kinds of seed you have planted, and observe which consist of embryo alone, and which are part embryo and part albumen.

At the same time, write in your note-book, as before, the results of observation. For example, to the question, Parts of the body? write for Indian corn, *Parts of body? Albumen. Embryo.* For Pea. *Parts of body? Embryo.*

EXERCISE LVI.

Parts of the Embryo.

TAKE out of the soil a bean which has begun to sprout. Remove the seed-coat, and let the parts of the embryo separate, as seen in Figs. 255 and 256.

FIG. 255.

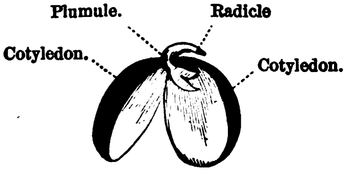
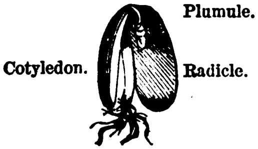


FIG. 256.



COTYLE'DON.—The bulky first leaf or leaves of the embryo—more or less formed before the growth of the seed begins.

Rad′icle.—The lower, or root-end, of the embryo.

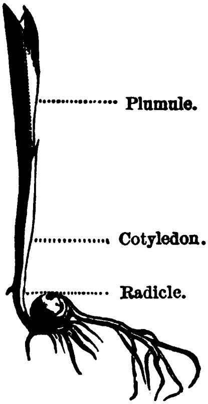
Plu′mule.—The first—the terminal bud—the upper end of the embryo.

Germina′tion.—The beginning of growth in a seed.

Read the names of the parts of the embryo given in Figs. 255 and 256. Look at the definitions of these words. Compare your specimen with the figures, and point out its Cotyledons; its Radicle; its Plumule. Handle your embryo with care, for it breaks easily. Has its radicle begun to put forth roots?

Take from your box a vigorous seed of Indian corn in which the roots have begun to grow, and compare it with Fig. 257.

Fig. 257.



Separate the embryo and albumen, and, if it has grown as much as the one pictured above, you may easily find the cotyledon, the plumule, and the radicle.

When you are sure that you have found the radicle or root-end of your embryo, that you know which part is cotyledon, and which plumule, take another seed of the same kind, but less grown—one where the root-end of the embryo has scarcely begun to swell—and see if you can find the parts.

FIG. 258.

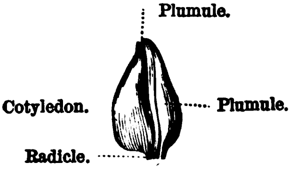


Fig. 258 represents such an embryo with the parts shown.

Point out and name the parts of the embryo of an apple-seed; of a pumpkin-seed; and of each of your specimens successively, as in former exercises. Which of your seeds has the largest plumule before growth begins? Have you any in which the embryo has at first no plumule at all?

Have you failed to find cotyledons in any embryo looked at?*

---

* If these experiments with seeds are made as early as April, in this climate, the children who have made them will be ready for more extended observations when planting in the garden begins. Most garden-seeds are too small to be separated into parts by young children. But, when growth begins, their parts enlarge, and a child, who has before studied larger seeds, will be able to identify the radicle, cotyledons, and plumule, without difficulty. In the kitchen-garden, a universal appendage of country-houses, the sprouting of the radish, onion, beet, parsnip, lettuce, tomato, carrot, cabbage, cucumber, etc., will furnish an excellent continuation of the study of seeds.

As the number of your observations increases, and their character varies, you will see more and more the value of your notes recording them.

To the question of this exercise, Parts of Embryo? you give the answers, as before, from direct observation of the structure of the embryo itself. If some seeds give uncertain appearances, wait till growth has proceeded a little further before you decide about them. By premature judgments you may fill your note-book with errors which you will be compelled to erase.

EXERCISE LVII.

Monocotyledons and Dicotyledons.

Fig. 259.

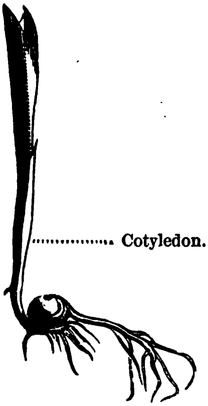
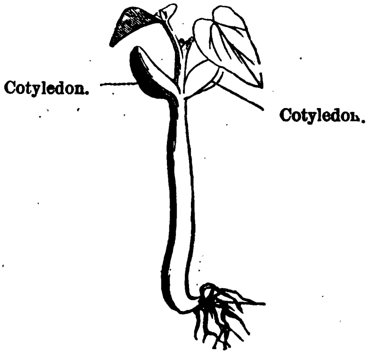


Fig. 260.



A Monocotyled′onous embryo has one cotyledon or seed-leaf (Fig. 259).

A DICOTYLED'ONOUS embryo has two cotyledons or seed-leaves (Fig. 260).

These are long, hard words, hard to pronounce, and hard to spell. But they are very necessary words in describing seeds. You can soon learn them.

Go over the seeds you have planted, and point out the dicotyledons. Show the two thick leaves that were packed within the seed-coat when the seed ripened?

Are any of your seeds monocotyledonous? If so, which?

Figs. 259 and 260 were drawn from plants that had grown a little. When your seeds have also grown a little, compare them one after another with these pictures. Look at your young bean-plant. Find the first node above the cotyledons. How many leaves are growing there? how many at the first node of the corn-stem? how many in each of your growing seeds?

Observe whether the cotyledons in all cases rise into the light and air. Observe whether all cotyledons are shaped alike, and also whether they resemble the true leaves of the plant. Write carefully in your note-book the decision you have made in this exercise about each of your seeds. You will have occasion to refer to it as soon as your plants have put forth perfect full-grown leaves.*

---

* A word of caution may not here be amiss. There is danger that the sympathy of teachers with bright and interested pupils will lead them to tell in advance what children can find out for themselves by continued observation. The connection between number of cotyledons and venation is an instance of such temp-

tation. This relation is an impressive one, and prominent in classification; but there is no need of haste in getting to it. By-and-by, when the leaves of his growing plants are well developed, by the aid of his note-book, the pupil might be put in the way of discovery, by asking him to make a list of his monocotyledons, and to give their venation in each case. Let him do the same with his dicotyledons. He will now see a perfect uniformity of relation in a few cases, and will be curious to know if it is everywhere constant. He will thus arrive at the induction by his own observation.

CHAPTER VII.

WOODY PLANTS.

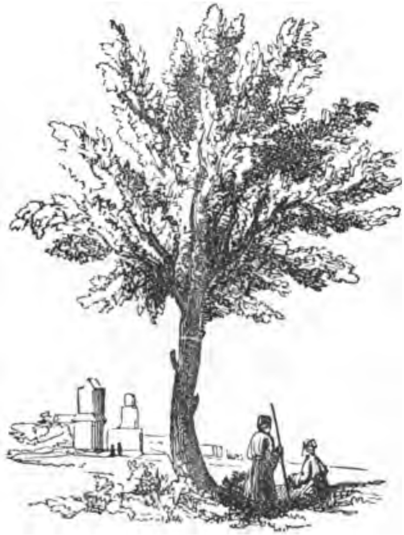
EXERCISE LVIII.

Their Different Kinds.

WHAT do you name all the soft, fragile plants that die down to the ground in winter?* Is there any name for all woody plants? Do you know of any woody plants that are not trees? If so, what do you call them? What is the difference between a young tree and a bush? Between a bush and a shrub?

The following pictures and definitions are given

FIG. 261.



Tree.

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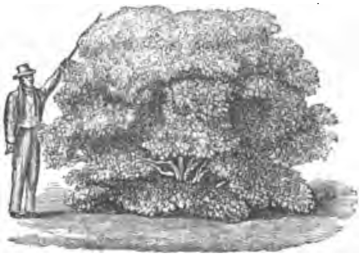
* See page 75.

to help you in distinguishing one group of woody plants from another. After carefully looking them over, you should go through the streets and the fields, and whenever you see a woody plant, decide whether it is a tree, shrub, bush, under-shrub, or vine. If you take with you a companion who is interested in the same pursuit, it will be all the better.

Although trees vary much in size, height, and shape, and are often not nearly so tree-like as the one represented by Fig. 261, yet it is not easy to mistake them when full grown. If you are doubtful whether a particular plant is a tree or shrub, remember that, when a full-grown woody plant, less than fifteen feet high, is slender, and perhaps has several stems starting together at or near the ground, as seen in Fig. 262, it is called a SHRUB.

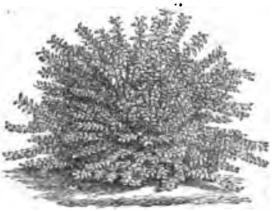
FIG. 262.



Shrub.

When a full-grown, woody plant, with several stems, is not more than five feet high, it is a BUSH.

FIG. 263.



Bush.

And when only two or three feet high, whatever its shape, it is called an UNDER-SHRUB. Slender, woody plants that cannot hold themselves up, but depend on other objects for support, or trail along the ground, are called VINES.

Besides this separation of woody plants into groups depending upon size and shape, they are again divided into two sorts, called Evergreen and Deciduous.

EVERGREEN trees, shrubs, etc., keep their foliage all the year round.

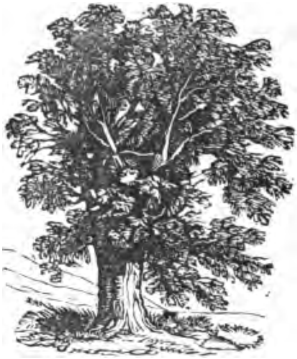
DECID'UOUS trees, shrubs, etc., lose their foliage in winter.

So that in winter it is very easy to tell Evergreens from deciduous plants. Look carefully at the foliage of Evergreens, and see if it resembles that of Deciduous trees.

EXERCISE LIX.

Parts of a Tree.

FIG. 264.

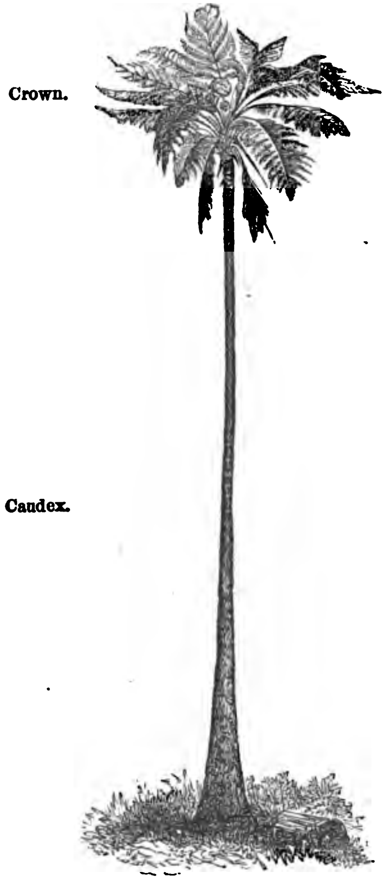


TRUNK.—The main stem of a tree.
HEAD.—The branching top of a tree.

Observe the varying lengths of the trunks in the trees about you. Measure the size around their trunks at different heights from the ground. Judge as well as you can at what distance from the ground the lowest limb starts from the trunk. Then test your judgment by measuring.

If you call the branches that start from the trunk *primary*, the branches which these put forth may be called *secondary* branches, and those given off next would be *tertiary* branches. In observing the heads of trees, fix your attention upon a primary branch, and see if you can find these divisions. Observe whether the tertiary branches bear still other branches.

FIG. 265.



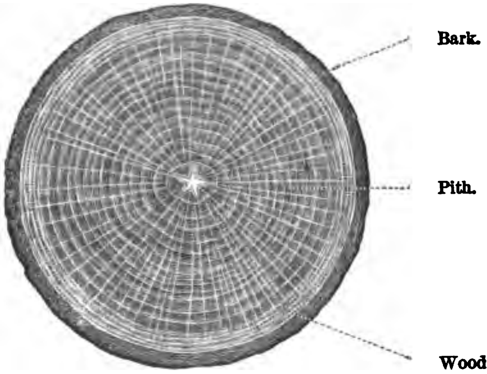
CAUDEX OR STOCK.—An unbranched trunk produced by the terminal bud alone (Fig. 265).

CROWN.—The collection of leaves at the top of a caudex.

EXERCISE LX.

Parts of the Trunk.

FIG. 266.

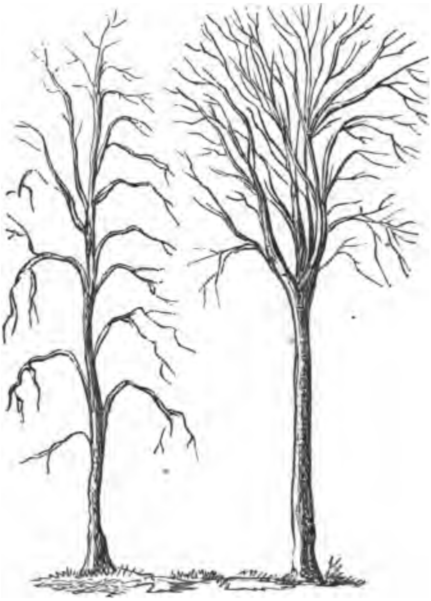


In living trees there grows each year a ring of wood between the old wood and the bark, and by counting the rings you can tell the age of the tree. Fig. 266 is a picture of the end of a tree-trunk. A dark and light streak, taken together, represent a yearly ring of wood. Can you tell how many years it was in growing? When you see saw-logs, find out their ages by counting the rings. Observe whether these annual layers are always of the same thickness. Notice whether the wood of a tree, from the centre to the circumference, is all of one color.

EXERCISE LXI.

Kinds of Trunk.

Fig. 267. **Fig. 268.**



Indefinite Trunk. Definite Trunk.

An Indefinite Trunk is one in which the trunk runs through to the top, the terminal bud growing on from year to year with more vigor than any of the branches.

In a Definite Trunk the stem breaks up into branches, and so disappears, as seen in Fig. 268.

Have apple-trees definite trunks?

Have pine-trees definite or indefinite trunks?

EXERCISE LXII.

Questions about Trees.

FIG. 269.

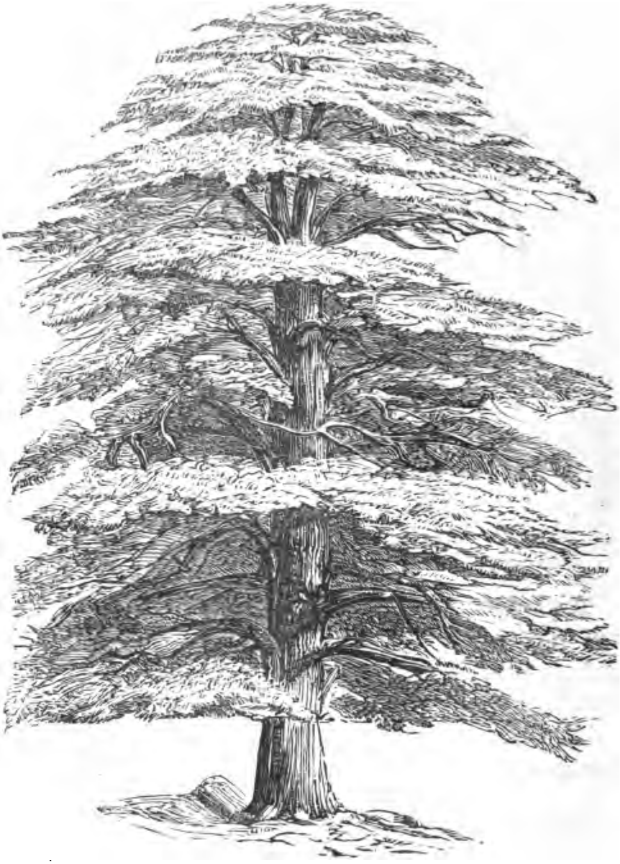


Fig. 270.

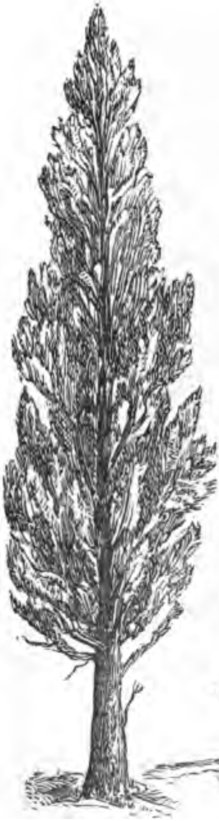


Fig. 271.

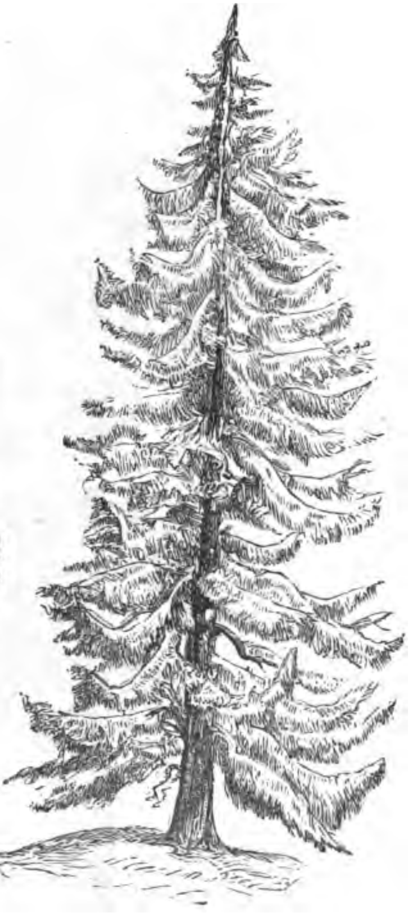


FIG. 272.

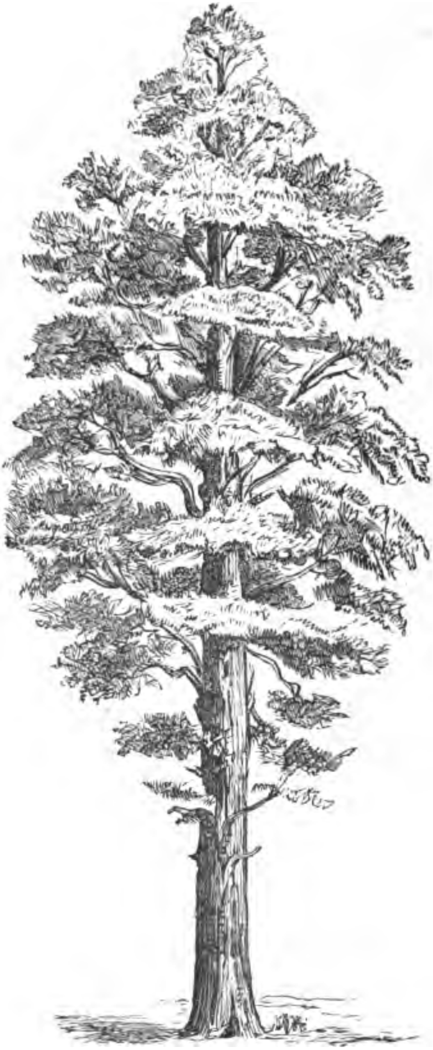
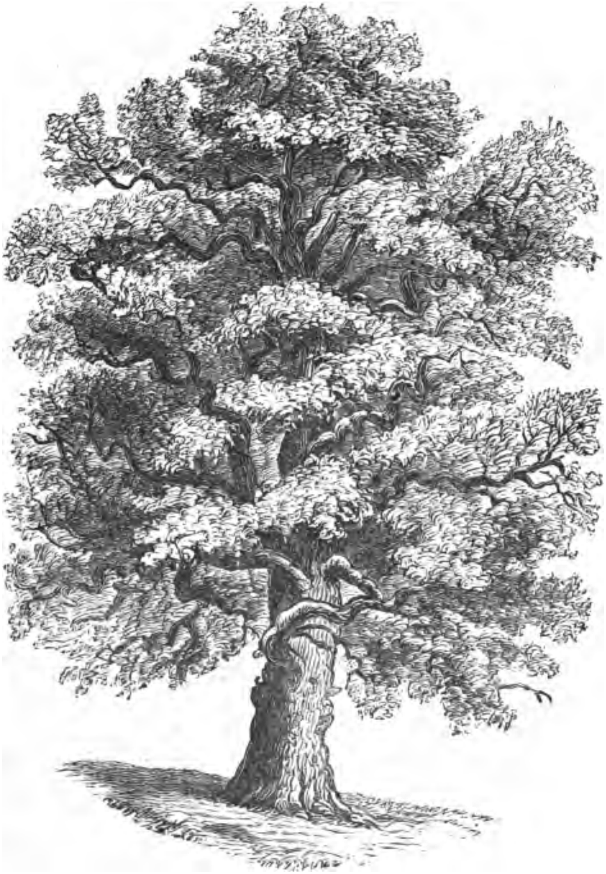


FIG. 273.



What is the attitude of the trunk in Fig. 269?

What is the form of the head?

Which are the longest—the upper, lower, or middle branches?

What is the direction of the branches?

Are the branches much subdivided?

What proportion of the trunk is below the lowest branches?

Observe whether field-trees and forest-trees differ in this respect.

Answer the same questions in regard to Fig. 270. Fig. 271. Fig. 272. Fig. 273.

Which of these pictures represent definite trunks?

Which indefinite trunks?

If the head of a tree is cone-shaped, which of its branches are longest?

If the head is round, which are longest?

Mention all the differences you see between Figs. 269 and 270.

Between Figs. 269 and 271.

Between Figs. 269 and 272.

Between Figs. 269 and 273.

Which of the pictures shows the most compact head?

Are its branches more subdivided than the others?

Now that you are somewhat acquainted with the woody plants of your neighborhood, find among them an evergreen and observe it carefully throughout the year. Describe, in your note-book, its appearance in winter. Watch it in spring, and note the changes produced on it by the warm weather. See if any of its foliage ever falls; or if it changes color in the course of the year. Watch for its flowers and fruit. Observe the appearance of its bark, and whether it looks the same in different parts of the tree.

Make and record similar observations upon a deciduous tree. Describe its winter aspect. What time does it put forth leaves? When does it flower? Does its foliage change in color after it is full grown? If so, how? When does it fall? Compare the bark of its trunk with that of its twigs.* Compare its bark with that of an evergreen.

In the same way watch the progress of a fruit-tree, after carefully observing its appearance before growth in the spring begins.

Every bush, shrub, and tree, passes each year through a succession of striking changes, which very few people ever observe. Let it be your purpose to see them all.

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* Twigs.—The remote ends of the branches.

CHAPTER VIII

THE LEAF-BUD.

EXERCISE LXIII.

Parts of the Leaf-bud.

FIG. 274.

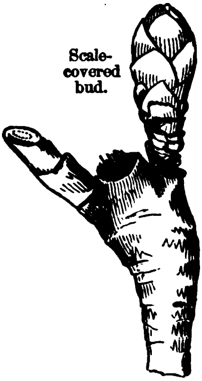


FIG. 275.

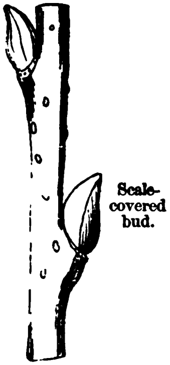
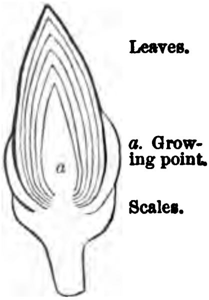


FIG. 276.



BUD-SCALES.—The covering of winter buds (Figs. 274, 275).

GROWING-POINT.—The soft extremity of the stem at the centre of the bud, and enclosed in the young unexpanded leaves and the bud-scales *a* (Fig. 276).

UNEXPANDED LEAVES are found in buds, as seen in Fig. 276.

The time to study bud-scales is in early spring, before the buds begin to swell. At this season gather buds from all the trees and shrubs within your reach.

Observe whether the branches from which they are taken have terminal buds.

Are any of these buds without a protective covering to the growing-point?

Observe in each case whether the scales are membranous, waxy, gummy, lined with down, wool, or dense hairs, or varnished upon the exterior.

What is the use of the gummy matter, varnish, and wax, around the bud?

Of what use are the woolly, downy, and hairy linings of the bud-scales?

What separates the gummed bud-scales when growth begins?

When you are familiar with the winter aspect of the buds upon the trees around, you will be interested in their unfolding. Observe what becomes of the scales on each of the trees you have examined. Scales may be changed into other parts, or they may fall off all together. Observe these changes. Notice the scars left by their fall.

PET'IOLAR scales are formed from the petiole.

STIP'ULAR scales are formed from the stipules.

FOLIA'CEOUS scales are formed from the blade of the leaf.

EXERCISE LXIV.

Vernation.

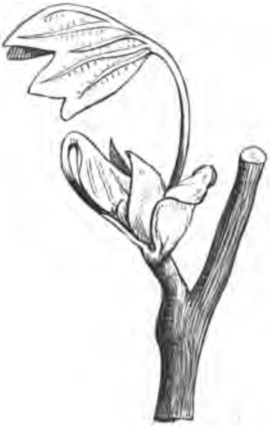
VERNATION is the way in which leaves are folded, rolled, and arranged, in the leaf-bud.

Observe the buds closely as warm weather approaches. When they are just opening out, examine them to find the various ways in which the young leaves are folded or rolled. If you are watchful at this time, you will be sure to find them at a moment when the growing leaves have not yet smoothed out the shapes they had while in the bud.

Fresh buds are also constantly appearing throughout the growing season, at the ends of stems and shoots* and in the axils of leaves. Observe the parts of such summer buds, and learn in what ways they differ from winter buds.†

WAYS IN WHICH LEAVES ARE FOLDED AND ROLLED IN THE BUD.

FIG. 277.



REC′LINATE, or INFLEXED′.—Folded from apex to base (Fig. 277).

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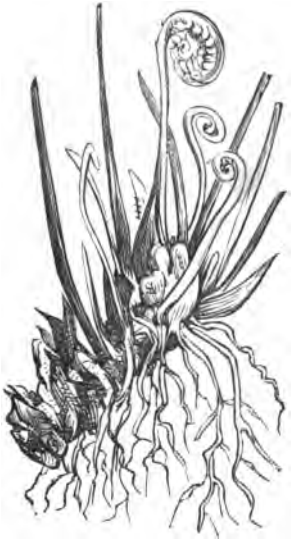
* SHOOT. Any fresh branch.

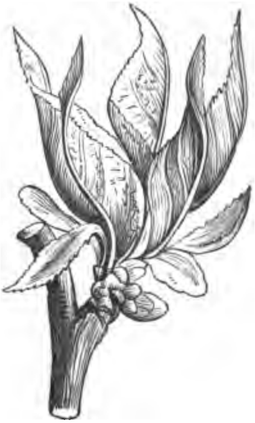
† Although the science of the folding and arrangement of the parts of buds has been called vernation (from *vernalis*, spring-time), yet its study need not be restricted to the spring season. All the features of buds illustrated here may be found equally well in summer upon growing plants.

FIG. 278.



CIR'CINATE.—Rolled from apex to base (Fig. 278).

FIG. 279.



CONDU'PLICATE.—Folded along the mid-rib so that the two halves are applied to each other (Fig. 279).

FIG. 280.

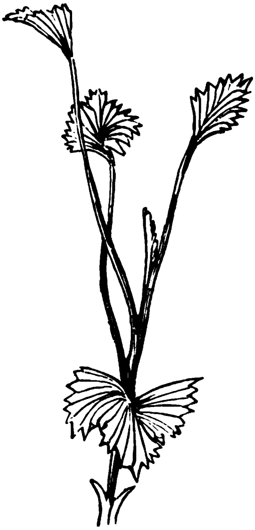
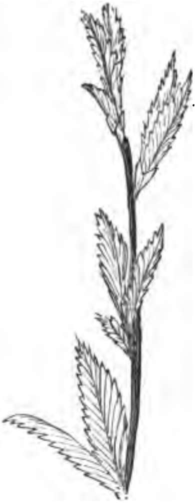
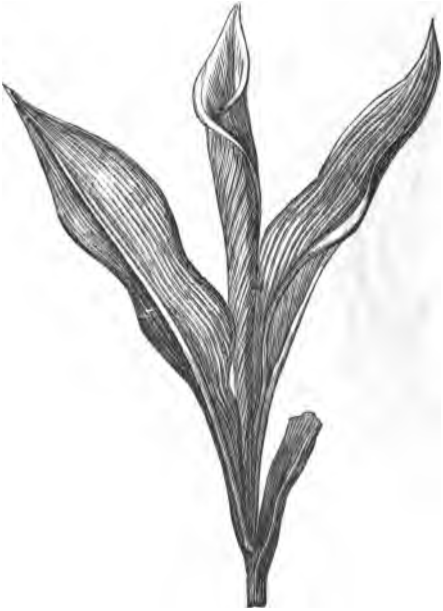


FIG. 281.



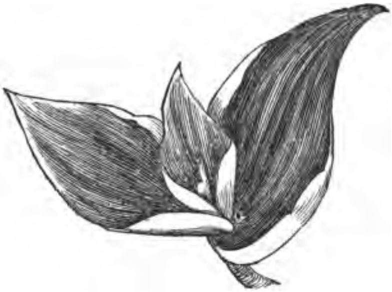
PLI'CATE.—Folded like a fan (Figs. 280 and 281).

FIG. 282.



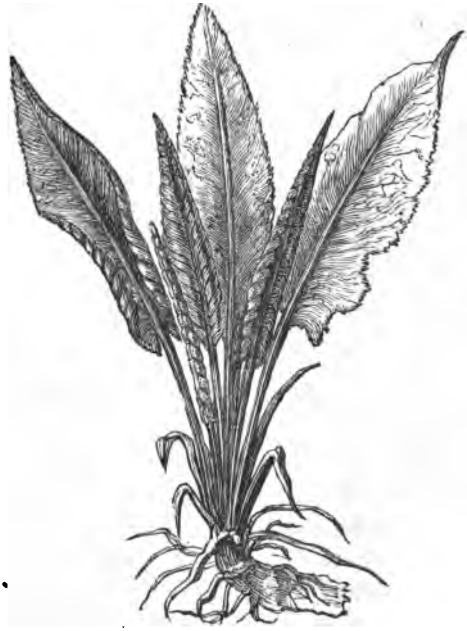
CON'VOLUTE.—With the leaf rolled spirally so that one edge is in the centre of the coil and one outside (Fig. 282).

FIG. 283.



IN'VOLUTE.—With both edges rolled inward toward the midrib (Fig. 283).

FIG. 234.



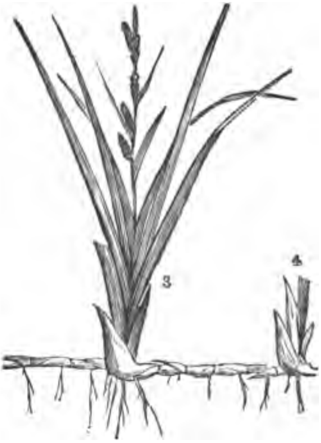
REV'OLUTE.—With both edges rolled outward toward the midrib (Fig. 284).

When leaves are neither folded nor rolled in the bud, they are said to be FLAT.

ARRANGEMENT OF LEAVES IN THE BUD.

By the arrangement of the leaves in a bud is meant the ways in which they are placed in relation to each other. For instance, Fig. 285 shows what is called the *equitant* arrangement.

FIG. 285.



EQ'UITANT.—When opposite conduplicate leaves overlap each other at the base, as seen in Fig. 285, the arrangement is called equitant.

Leaves are always arranged in one or other of the two ways called valvate and imbricate.

The VAL'VATE arrangement is seen when the edges of corresponding leaves barely touch each other.

The IM'BRICATE arrangement is seen when the edges of the leaves overlap each other. Fig. 285 shows an imbricate arrangement.

The directions for observing the folding and rolling of leaves apply also to the study of their arrangement. But there are several different ways in which imbricate leaves are placed, and it is sometimes quite difficult to make them out. The best way to study the arrangement of leaves in the bud is to cut off the top of the bud with a sharp knife, and look down on the cut edges, which will show not only whether the leaves are imbricate or valvate, but also, if they are imbricate, the particular mode of overlapping. In most cases, however, a magnifying-glass is needed to show the details of a complex arrangement, and so we shall leave the illustration of this branch of vernation to be taken up again in the Second Book of Botany.

In your notes about trees you can now include your discoveries about the buds of the particular kinds of woody plants you are studying.

Answer the following questions in regard to each sort by frequent observations made during their growth. Answer them in writing in your book for each of the woody plants that you have selected to study throughout the year.

QUESTIONS ON THE BUDS OF A PLANT.

When do the buds begin to swell?

How long are they in unfolding?

Are they naked, scaly, woolly, or gummy?

Can you find the growing point within them?

Is there any appearance of leaves within them?

What are the size, color, and structure, of the bud before swelling commences?

How long is it from the first bursting of the bud till the leaves are full grown?

What changes of color do the leaves undergo during growth?

Are the first-formed leaves as large as those formed later in the season?

What becomes of the bud-scales as the buds unfold?

CHAPTER IX.

STEM AND ROOT.

EXERCISE LXV.

What are Roots?

Carefully pull up a buttercup, or any common plant, and rinse away the dirt from the roots.

Take the stem-schedule on page 63, and answer its questions as if they were asked concerning these roots.

Look at the tip of the stem, or of one of the branches of the stem, and compare it with the tip of a rootlet.

What is the difference between them?

What appendages has the stem that you do not find on the root?

How do the root and stem differ in color?

How in direction of growth?

Where do branches start from on the stem?

Are they regular or irregular?

Where do the root-branches start from?

Pull up another plant and examine the root and stem in the same way. Do you find the same differences as before?

Examine as many plants as you can, by thus comparing the root and stem, so as to find out for yourself the differences between them.

Get a potato that has begun to sprout, and observe its surface?

Have you seen any thing like this upon roots?

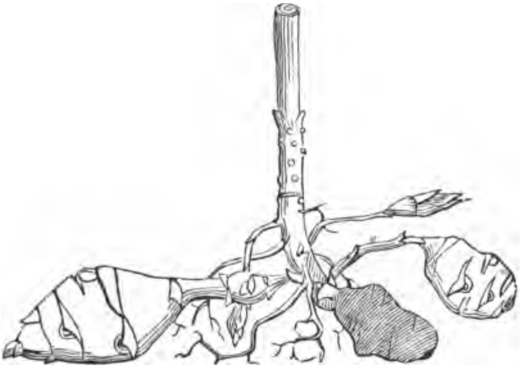
Did the potato grow under or above the ground?

Have you ever found buds upon roots?

EXERCISE LXVI.

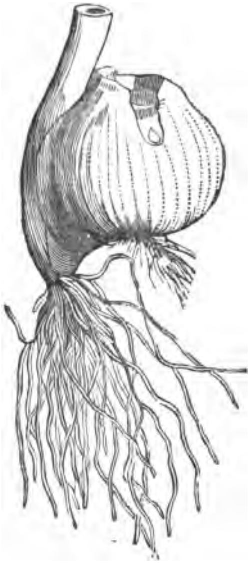
Tubers, Bulbs, Corms, Rhizoma.

FIG. 286.



TU'BERS, thickened portions of underground stems.

Fig. 287.



Corm.—When the base of an underground stem is abruptly thickened so as to resemble a tuber, it is called a corm (Fig. 287).

Fig. 288.

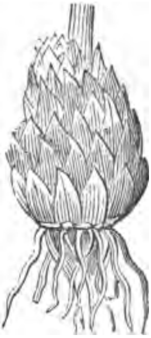
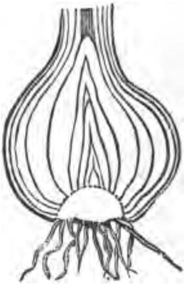


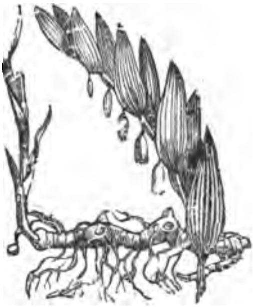
Fig. 289.



Bulb.—A mass of thickened, scale-like leaves, growing from a flat or conical solid base, from the under side of which, roots are given off (Figs. 288, 289).

Rhizo′ma.—A stem more or less covered by the soil, which gives off buds above, and roots below, as seen in Fig. 290.

Fig. 290.



Point out the root and the stem of an onion?

Is the bulb a stem or root?

Examine a growing hyacinth, and find the root and the stem.

Which is the root and which the stem in a lily?

Look for sweet-flag, blue-flag, peppermint, knot-grass, Solomon's-seal, and try the stem-schedule as before, upon their entire underground portions. You will find flag in marshes and by the water's side; Solomon's-seal, trillium, artichoke, etc., in meadows and old gardens. If you cannot at once get abundant specimens illustrating this exercise, put it off till you have an opportunity to gather a good variety of such plants as are here named.

Observe the lower joints of the stem in the plants of a cornfield. Look at a good many of them. Can you tell whether the branches you see growing on this part of some of the stalks are stem-like or root-like?

Observe the stem of ivy. Notice the little fingers it puts out for support. Are they stems or roots?

Would you now say that all the parts of plants growing above-ground are stems? Would you say that all the parts of plants growing underground are roots?

CHAPTER X.

FRUIT.

EXERCISE LXVII.

What is Fruit?

Pluck from the vine of the pea or bean several pods of different ages, from one still enveloped by the flower, to one that is full grown. Compare the youngest pod you have gathered with Fig. 192. What part of the pistil becomes the pod? Compare it with Fig. 193. How many carpels has the ovary of the bean or pea?

Observe the contents of this pod.

What name is given to these little soft bodies?

Answer.—O′vules.

Compare these ovules with the contents of a full-grown pod. What are these full-grown ripe bodies called?

What name is given to pod and contents taken together?

Answer.—Fruit.

What is every ovary and its contents?

Answer.—It is fruit. The fruit of a plant is its ripened ovary.

By what words would you distinguish the young from the mature ovary?

Examine all the flowers that are just fading, and look for the ovules in their unripe fruit. Find the ovules of a young apple. Of an unripe cucumber. Of an unripe tomato. Of any unripe fruit you see growing within reach.

Observe the same plants when the fruit is ripe, and compare the aspect of the seeds with the appearance the ovules presented.

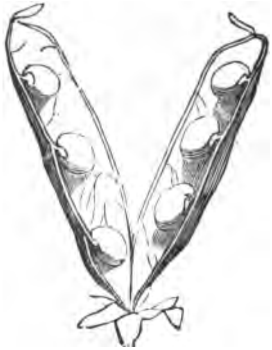
Try to count the carpels in all the ovaries you examine. Observe whether they are grown together or not. Count the carpels shown in Fig. 197. Do you see the three white lines passing outward from the centre in this picture? Should you judge that the carpels from which this picture was taken were grown together? Search, among plants that are going to seed, for ovaries resembling this one.

EXERCISE LXVIII.

Sutures and Dehiscence.

Look among the ripe and dry pea and bean pods, upon the dry vines, for those that have begun to open. Examine the edges of the separate parts. Do you see something like a joint where the two parts were united? Compare them with Fig. 291.

Fig. 291.



Dehis'cence.—The opening of a seed-vessel at maturity. See Fig. 291.

Sut'ure.—A seam. The line along which dehiscence occurs, and so permits the escape of the seeds.

Ven'tral Suture.—The inner suture of a carpel. The one looking toward the centre of the flower. In Fig. 291, it is the suture along which the ovules are attached.

Dor'sal Suture.—The outer suture. See Fig. 291.

What name is given to those joints in ovaries at which they open when the seeds are ripe? How many sutures has a bean-pod? To which suture are the beans attached?

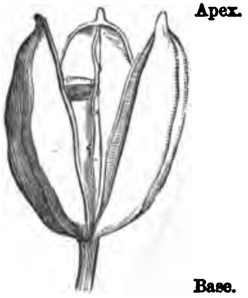
When an ovary opens spontaneously, and thus liberates its seeds, it is called a DEHISCENT OVARY. When it does not open, it is an INDEHISCENT ovary.

Are there any indehiscent ovaries among the fruits of the garden or farm?

Mention all the dehiscent ovaries you can think of.

Again turn to Fig. 197, and compare it with Fig. 292.

FIG. 292.



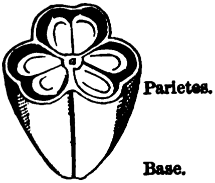
Obtain the ripe fruit of IRIS [flower de luce], and compare it with the pictures? Is it a dehiscent or indehiscent fruit? Can you find sutures at which the carpels open? What do you call the suture at which the seeds are attached? What do you call the line in the outer wall of each carpel, opposite the ventral suture?

BASE.—The bottom of the ovary. The end attached to the peduncle. Figs. 292, 293.

A′PEX.—The top of the ovary. Fig. 292.

DISSIP′IMENTS.—The partitions between the cells of syncarpous [carpels united] ovaries. Fig. 293.

FIG. 293.



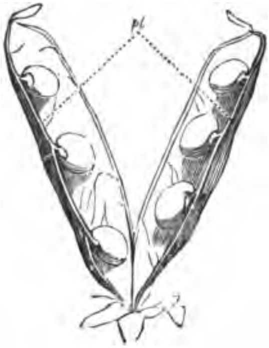
PARI'ETES.—The wall of the ovary. Fig. 293.

AX'IS.—The central part of the ovary where the ventral sutures join together. *a*, Fig. 293.

EXERCISE LXIX.

Parts of Carpels.

FIG. 294.



VALVES.—The parts into which carpels separate by dehiscence. Fig. 294.

PLACEN'TA.—The cord along the ventral suture, to which the ovules are attached. It is the "string" that pulls off in preparing string-beans for the table. *pl*, Fig. 294.

Find the placenta in full grown bean and pea-pods. Find it in little ones where you can just see the ovules. Observe the little stem by which the ovules and seeds are attached to the placenta. By what name is it known?

Answer.—It is called the FUNIC′ULUS.

QUESTIONS UPON ANY OVARY.

Is it dehiscent or indehiscent?

IF DEHISCENT—

How many carpels compose it?
Are the carpels grown together?
Point out the sutures?
Which is dorsal and which ventral?
Find the valves. The placenta. The funiculus.

IF INDEHISCENT—

Can you count the carpels?
Look for the ovules or seeds.
Point to the funiculus. The placenta.
Point out the base of the ovary. The apex. The axis. The parietes. The dissipiments.

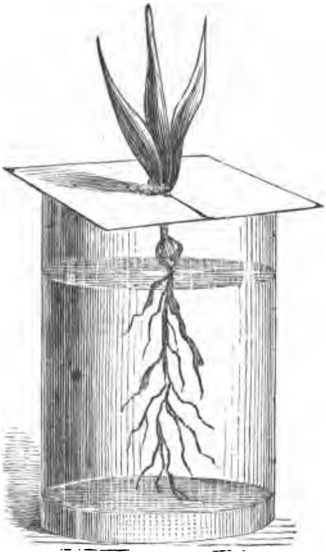
CHAPTER XI.

THE ACTIONS OF PLANTS

EXERCISE LXX.

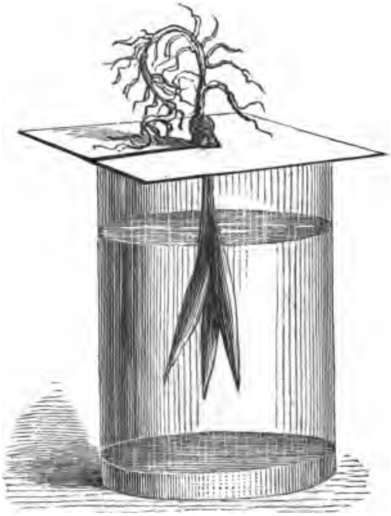
Root-action and Leaf-action.

FIG. 295.



COVER a tumbler with a piece of card-board, cut as seen in Fig. 296. Pull up by the roots a young growing plant of any kind, and slip it root downward into the hole made in the centre of the card-board. Pour into the tumbler water enough to cover the roots, and expose the leaves to sunshine.

FIG. 296.



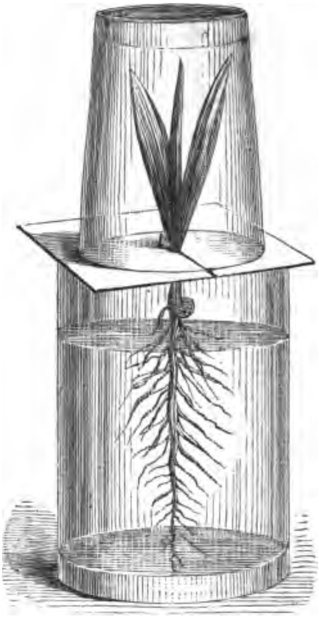
Into another tumbler of water with a similar cover put a second plant, leaves downward, as shown in Fig. 297, and expose it to sunshine.

After a few hours, compare the two plants. How has it fared with the one that had its roots in water? What is the appearance of the other?

Let us now find, if we can, what was going on in the plant that kept up its freshness.

Arrange a glass of water with a cover of slit cardboard as before. Place in it a plant, root downward, and cover the leaves with a glass, as shown in Fig. 297. Let it stand for a time in the sunshine. In a little while look at the inverted tumbler. What do you see upon its inner surface? Where did it come from? What had the roots to do with it?

FIG. 297.



Invert a tumbler in this way above the roots of a plant placed as in Fig. 296. Do you, in this case, get moisture on the inside of the inverted tumbler? Can you not make leaves do the work of roots?

Strip a plant of its leaves and place it under a glass as in Fig. 297, with the roots in water. Place it in the sun as before and see if any moisture gathers upon the glass.

What can be done by a plant with leaves, that cannot be done by a plant without leaves? What, then, is one use of leaves?

The action of the root in sucking up water is named ABSORPTION.

The action of leaves in giving off water is called TRANSPIRATION.

The roots absorb. The leaves transpire.

There are two more words that these experiments illustrate. The first of these is the word ORGAN. An organ is any part of a plant or animal that does a particular kind of work different from that done by other parts.

Is the root an organ? What do your legs do that no other part of your body can do? Are they organs? Is your tongue an organ? Are leaves organs?

The other word to be explained is FUNCTION. Organs have functions. The function of an organ is what it does. What is the function of your eye? What is the function of a bird's wings? What function of roots have you discovered by your experiments? What is one of the functions of leaves?

Remember that the particular work any organ does is its FUNCTION.

LEAF SCHEDULES.

Schedule One.

See Page 19, *Exercises I., II., III., IV., and V.*

Parts?	
Venation?	

Schedule Two.

See Page 27, *Exercise VI.*

Parts?	
Venation?	
Margin?	

Schedule Three.

See Page 30, *Exercise VII.*

Parts?	
Venation?	
Margin?	
Base?	

SCHEDULE FOUR.

See Page 32, *Exercise VIII.*

Parts ?	
Venation ?	
Margin ?	
Base ?	
Apex ?	

SCHEDULE FIVE.

See Page 34, *Exercise IX.*

Parts ?	
Venation ?	
Margin ?	
Base ?	
Apex ?	
Lobes ?	

SCHEDULE SIX.

See Page 36, *Exercise X.*

Parts?	
Venation?	
Margin?	
Base?	
Apex?	
Lobes?	
Sinuses?	

SCHEDULE SEVEN.

See Page 38, *Exercises XI. and XII.*

Kind?	
Venation?	
Margin?	
Base?	

SCHEDULE SEVEN.—(*Continued.*)

Apex?	
Lobes?	
Sinuses?	
Shape?	

SCHEDULE EIGHT.

See Page 44, Exercises XIII. and XIV.

Kind?	
Venation?	
Margin?	
Base?	
Apex?	
Lobes?	
Sinuses?	
Shape?	

SCHEDULE EIGHT.—(*Continued.*)

Petiole?	
Color?	
Surface?	

SCHEDULE NINE.

See Page 50, *Exercise XV.*

Parts?	
No. of Leaflets?	

SCHEDULE TEN.

See Page 51, *Exercise XVI.*

Parts?	
No. of Leaflets?	
Kind?	

SCHEDULE ELEVEN.

See Page 56, *Exercises XVII. and XVIII.*

Parts?	
No. Leaflets?	
Kind?	
Variety?	

◆

STEM SCHEDULES.

SCHEDULE TWELVE.

See Page 63, *Exercises XXI. and XXII.*

Parts?	
Appendages?	

LEAF.—

SCHEDULE THIRTEEN.

See Page 65, *Exercise XXIII.*

Appendages?	
Leaf-position?	

LEAF.—

SCHEDULE FIFTEEN.

See Page 68, *Exercise XXIV.*

Appendages?	
Leaf-position?	
Leaf-arrangement?	

LEAF.—

SCHEDULE SIXTEEN.

See Page 70, *Exercise XXV.*

Appendages?	
Leaf-position?	
Leaf-arrangement?	
Shape?	

LEAF.—

SCHEDULE SEVENTEEN.

See Page 74, Exercise XXVI.

Appendages ?	
Leaf-position ?	
Leaf-arrangement ?	
Shape ?	
Attitude ?	

LEAF.—

SCHEDULE EIGHTEEN.

See Page 75, Exercise XXVII.

Appendages ?	
Leaf-position ?	
Leaf-arrangement ?	
Shape ?	
Attitude ?	
Color ?	

Schedule Eighteen.—(*Continued.*)

Surface ?	
Size ?	
Structure ?	

Leaf.—

◆

INFLORESCENCE SCHEDULES.

Schedule Eighteen.

See Page 81, *Exercises XXVIII., XXIX., and XXX.*

Parts ?	
Attitude ?	

Leaf.—

Stem.—

SCHEDULE NINETEEN.

See Page 86, *Exercises XXXI. and XXXII.*

Parts?	
Attitude?	
Position?	

LEAF.—

STEM.—

SCHEDULE TWENTY.

See Page 89, *Exercise XXXIII.*

Parts?	
Attitude?	
Position?	
Kind?	

LEAF.—

STEM.—

SCHEDULE TWENTY-ONE.

See Page 95, *Exercise XXXIV.*

Parts?	
Attitude?	
Position?	
Kind?	
Variety?	

LEAF.—

STEM.—

FLOWER SCHEDULES.

SCHEDULE TWENTY-TWO.

See Page 98, *Exercises XXXV., XXXVI., and XXXVII.*

Names of Parts.	No.	
Calyx ?		
Corolla ?		

LEAF.—

STEM.—

INFLORESCENCE.—

SCHEDULE TWENTY-THREE.

See Page 98, *Exercises XXXV., XXXVI., and XXXVII.*

Names of Parts.	No.	
Perianth ?		

LEAF.—

STEM.—

INFLORESCENCE.—

SCHEDULE TWENTY-FOUR.

See Page 100, *Exercises XXXVIII. and XXXIX.*

Names of Parts.	No.	Description.
Calyx?		
Corolla?		

LEAF.—

STEM.—

INFLORESCENCE.—

SCHEDULE TWENTY-FIVE.

See Page 102, *Exercise XL.*

Names of Parts.	No.	Description.
Calyx?		
Corolla?		

LEAF.—

STEM.—

INFLORESCENCE.—

SCHEDULE TWENTY-SIX.

See Page 102, *Exercise XL.*

Names of Parts.	No.	Description.
Perianth?		

LEAF.—

STEM.—

INFLORESCENCE.—

SCHEDULE TWENTY-SEVEN.

See Page 104, *Exercise XLI.*

Names of Parts.	No.	Description.
Calyx?		
Corolla?		
Stamens?		

LEAF.—

STEM.—

INFLORESCENCE.—

SCHEDULE TWENTY-EIGHT.

See Page 106, *Exercises XLII. and XLIII.*

Names of Parts.	No.	Description.
Calyx?		
Corolla?		
Stamens?		
Pistil?		

LEAF.—

STEM.—

INFLORESCENCE.—

NOTE.—This is the last form of schedule in the book. As the pupil passes on from exercise to exercise, he will be enabled to add one feature after another to his descriptions; but the mode of inserting these new points will not make any change in the form of the schedule.

OPINIONS CONCERNING

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